OPTIMIZING C-17 PACIFIC BASING

GRADUATE RESEARCH PAPER

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Abstract

Substantial savings may be realized by optimizing C-17 flight operations in the Pacific. Aligning the C-17 operating locations to the mission demand may reduce flight hour expenditure by decreasing the positioning and de-positioning requirements. This research paper evaluated C-17 missions in the Pacific during calendar years 2006 through 2012. JB Pearl Harbor-Hickam, Hawaii, JB Elmendorf-Richardson, Alaska, Yokota AB, Japan, and Travis AFB, California, were used as the four test bases for purposes of comparison and optimization.

Based upon Transportation Working Capital Fund (TWCF) flight time expenditure, Yokota AB appears to be the optimal operating location for C-17s in the Pacific. If all C-17s operating on TWCF missions in the Pacific in 2006-2012 had operated from Yokota AB exclusively, but had still flown their missions otherwise identically, they would have flown 16,860 less hours. Based upon the FY14 TWCF rate for C-17s, that reduction would represent a savings to the DOD of almost $245 million in FY14 dollars. In particular, Channel, Contingency, and SAAM mission sets would all see flight time reductions when compared to the missions as they were actually flown. The changes would allow DOD to realize actual savings in TWCF dollars or service additional missions with C-17s.

This research paper is dedicated to my wife and three daughters. These four ladies make my life whole - without them I would not be the man I am today. Thank you all for providing the love and support I needed to complete this project.

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Judd W. Baker

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I. Introduction

Background

While serving as the Chief of the Airlift Control Team (ALCT), Air Mobility Division (AMD), 613th Air Operations Center (AOC), Pacific Air Forces (PACAF), the researcher became quite familiar with the airlift requirements and operations of the Pacific theater. It became apparent that the theater and strategic airlift assets over which PACAF has Operational Control (OPCON) are not necessarily assigned to the locations which service the theater's requirements while also optimizing the capabilities of the aircraft. Politics certainly plays a large role in the basing of systems and support.

Problem Statement

The researcher believes the organization and location, or network design, of airlift aircraft in the Pacific can be improved upon, resulting in money and time savings by reducing the time aircraft are required to be airborne. If the network design is not optimal, money and time are being wasted on positioning and de-positioning aircraft in support of Pacific theater airlift movement.

This research will determine if the airlift network design is optimized for the primary users in the Pacific theater. Simply put, are the aircraft operating out of the right places in order to get the right stuff to the right place at the right time?

Research Objectives

The objective of this research is to ensure that the US military has the correct airlift assets placed in the appropriate locations in order to conduct efficient operations. A review of Pacific force basing is in-line the new *PACAF Strategic Plan*

2013, currently a focus item for the PACAF Commander. In support of the rebalance to the Asia-Pacific region, the Secretary of Defense (SECDEF) has laid out four concepts: *Principles, Partnerships, Presence, and Power Projection*. *Principles* is about building peace and prosperity in the region. *Partnerships* means adapting traditional alliances to new security challenges and opportunities. *Presence* refers to the distribution of US defense posture over a wider geographic range, in order to make it more sustainable and resilient. *Power Projection* will occur when the US sustains investments to project airpower and meet its security commitments in the region (PACAF, 2013). Airlift operations in the Pacific, conducted with C-17s, represent a Principles-driven opportunity to build Partnerships and show Presence through Power Projection. Optimizing the expenditure of C-17 flight time is critical to the strategy in the Pacific.

In order to provide a foundation for the reader, military airlift doctrine will be reviewed. A short overview of airlift in the Asia-Pacific region will also be provided. The basing and structure of the Pacific en route system will be examined. Finally, the use and application of the C-17 in the Pacific will be discussed.

An understanding of the Pacific airlift network in its current form is critical: how the Pacific uses its main, secondary, and tertiary operating bases. Other than the west coast of the US (to include Alaska), the Pacific airlift system is a network of lily pads, using both large and small islands as staging points. A hub and spoke system is utilized, with a handful of main operating bases serving as distribution points for the many smaller airfields in the theater.

The researcher hypothesizes that, given the assumptions and limitations discussed later in this paper, C-17 operations should be consolidated and moved forward into the first or second Pacific island chain, e.g. Japan or Guam. Airlift ports in Hawaii and Alaska would continue to be utilized in a strategic fashion, but as more of an en route (or staging) location and not necessarily as a permanent home of strategic lift.

Research Focus

The research was conducted by examining the current airlift force laydown in the Pacific. Additional focus was given to the basing locations of the C-17s assigned to PACAF. The research focus could have been expanded beyond aircraft to include subjects such as the Pacific en route airlift structure (e.g., aerial port, maintenance, command and control), ground supply lines, fuel support, and warehousing and storage facilities. However, the focus was kept narrow: only the actual aircraft weapon systems were reviewed; the location of support systems and personnel would naturally follow the aircraft if they were to be reassigned.

Substantial savings may be realized by aligning the C-17s with the appropriate location(s) for their mission. Decreasing positioning and de-positioning time and improving maintenance reliability by reducing "small group dynamics" are some possible areas for savings. Improvements are proposed based upon the final analysis.

The research has two facets. First, it was determined if C-17 operations are conducted at the optimal locations, based upon past missions conducted. If they were found to be located incorrectly, an effort to ascertain where those assets should be placed for both maximum efficiency and effectiveness was undertaken.

Methodology

This study follows the normative model for judgment and decision making. A very simple definition of normative model is that which yields the best consequences for the future. Normative models are the result of reflection and analysis. That a normative model labels an outcome as "better" implies that the model truly defines what "better" means. The idea is that good is something that can be measured and compared (Baron, 2004). In the case of this study, the "better" outcome is that which results in the least hours flown by C-17s in the Pacific. Critics may look for advantages by honoring sunk costs, which might outweigh other obvious disadvantages. Some normative models have a relationship between two or more possible outcomes that can be judged directly. In most cases, trade-offs must be dealt with (Baron, 2004). This study is a prescriptive model in which the current situation was evaluated, and alternative solutions were proposed.

In order to evaluate the Pacific's current situation, airlift data was extracted from Air Mobility Command's (AMC) mission databases. AMC tracks and stores every mission flown by a mobility aircraft worldwide. The data extracted were the C-17 sorties that occurred in the calendar years 2006-2012 in which either the arrival or departure location (or both) was in the Pacific theater. A city pair was created from each sortie, with only one departure location and one arrival location. These city pairs, aggregated, constituted the original set of data.

Four new sets of data were then created by replacing each occurrence of Joint Base Pearl Harbor-Hickam, Hawaii (PHIK) or Joint Base Elmendorf-Richardson, Alaska (PAED) with one of the four test bases. The four test bases were PHIK, PAED, Yokota

Air Base, Japan (RJTY), and Travis Air Force Base, California (KSUU). City pairs that already included PHIK and were then replaced by PHIK, for example, did not change. Likewise for city pairs that already included PAED and were replaced by PAED. The goal was that each of the four new data subsets represented a new scenario, or normative model, in which all C-17 operations in the Pacific hub-and-spoke out of *only one* primary location amongst the four test bases.

Each of the five data subsets were compared against one another by applying various filters, including the owning organization of each aircraft and mission types flown during each sortie. This process allowed for a focused comparison among like missions and scenarios. The variable amongst the sortie data is flight time, wherein a savings, or reduction, in flying time was considered a positive outcome.

Assumptions/Limitations

The researcher assumed that due to greater flight distances in the Pacific, the Pacific-based C-17s would need to be utilized as intra-theater airlifters, and that CONUS-based C-5s and C-17s would need to serve in the role of strategic inter-theater airlifters. These assumptions may drive a change to where the aircraft and their support equipment are currently located.

The acquisition of data had very little limitation. The data was readily available, and supporting participants were eager. However, a thorough analysis of forecast demand would have likely required this GRP to examine plans that are at the SECRET or TOP SECRET classification levels. Instead of raising the classification level of this GRP by reviewing actual Contingency Plans (CONPLAN), Time-Phased Force Deployment

Data (TPFDD), or Operations Plans (OPLAN), the researcher utilized the actual missions already conducted.

The four test bases: Joint Base Pearl Harbor-Hickam (PHIK), Joint Base Elmendorf-Richardson (PAED), Yokota Air Base (RJTY), and Travis Air Force Base (KSUU) were chosen because they are the primary cargo hubs servicing the Pacific theater. Use of these four bases allowed for the largest data sets of missions that have already occurred. The normative models created by using these four bases allowed the data to depict which of these four bases would be the most efficient for C-17 operations; optimizing missions by reducing flight time.

Any permanent movement of aircraft would likely encounter resistance from members of Congress. Congress has shown a propensity to prioritize the interests of their district over what may be in the best overall interest of the nation. For example, proving the hypothesis would mean C-17s should move out of Hawaii and Alaska, possibly requiring the movement of C-130s in response to the changes to theater force laydown. A favorable response to that level of movement from state representatives is unlikely.

Implications

The intent of this research was to increase and enlighten the dialogue about the appropriate use of airlift assets in the Pacific. AMC is the Department of Defense’s largest consumer of petroleum products, so AMC divisions are continually examining proposals to conserve fuel. One fuel conservation method is to reduce the amount of time aircraft are airborne. It is possible that this research may shed light on a subject very few have considered, but it could also become a lightning rod for criticism given its political implications.

Preview

The following pages contain a literature review to provide background on military airlift doctrine, the Pacific theater, and the C-17 aircraft. The methodology section details how results were obtained and what data was used, and the analysis section thoroughly examines the data. The final section provides an interpretation of the data, as well as conclusions and recommendations for application as well as future research.

II. Literature Review

Doctrine

No military research report or paper can be considered complete without a thorough review of the applicable military doctrine. In the case of this paper, doctrine is used to set the stage; to provide the foundation upon which the remainder of the literature and data will be built. Joint Force and Air Force doctrinal documents were reviewed for their application to air mobility operations on the whole, to include the force structure and basing required to conduct and support airlift operations.

Joint Publication 3-0, Joint Operations (JP 3-0), discusses considerations for Phase I: Shaping, with respect to a applicable campaign plans, focusing on stability operations. While the Commander of Air Force Forces (COMAFFOR) for the theater, or from the larger perspective, the entire US Air Force, is responsible for organizing, training, and equipping (OT&E) Air Force forces, it is the Joint Force Commander (JFC) who is the supported commander, tasked with achieving a desired military end state. *JP 3-0* states, "To achieve the desired military end state and conclude the operations successfully, JFCs must integrate and synchronize stability operations with other operations (offense and defense) within each major operation or campaign phase" (JCS, 2011). Therefore, *JP 3-0* tasks JFCs with Phase I responsibilities, to include maintaining access to operational areas "where they are likely to operate, ensuring forward presence, basing (to include availability of airfields), freedom of navigation, and cooperation with allied and/or coalition nations to enhance operational reach" (JCS, 2011). In the case of this paper, the JFC for the Pacific theater is the Commander of United States Pacific Command (CDR USPACOM).

Preparation for joint operations occurs in the form of planning, with planning guidance found in *Joint Publication 5-0 (JP 5-0), Joint Operations Planning*. The Guidance for Employment of the Force (GEF) provides two-year direction to combatant commands (CCMDs) for operational planning, force management, security cooperation, and posture planning. Amongst many other topics, the GEF addresses Global Force Management (GFM) and Global Defense Posture. Global Posture guidance includes broad DOD strategic themes, as well as basing and force structure guidance, to ensure the CCMD's ability to provide theater and global security, respond to contingency scenarios, and provide strategic flexibility. GFM guides the sourcing of forces for CCMDs, providing recommendations for force assignment and allocation (JCS, 2011).

Force assignment is further explained in the biennial Global Force Management Implementation Guidance (GFMIG) document. The GFMIG integrates complementary assignment, apportionment, and allocation information into a single document. The Joint Staff (JS) J-8 oversees preparation of the document, updating and submitting it every two years for final approval by the US Secretary of Defense (SECDEF). The GFMIG provides essential information and direction on the alignment of forces to CCMDs, and includes the Forces For Memorandum (Forces For). The Forces For Memorandum provides SECDEF's direction for assigning forces to CCMDs and serves as the record of force assignments. The Forces For Memorandum is updated annually; in even years it is included in the GFMIG, in odd years it is published on the JS J-8 website (JCS, 2011). Through Forces For, SECDEF has assigned Combatant Command authority (COCOM) of 16 primary C-17s plus two backup aircraft to US Transportation Command (USTRANSCOM), and OPCON to USPACOM, who has further delegated OPCON to PACAF. The PACAF C-17s are split evenly between the 15th Wing at Joint Base Pearl Harbor-Hickam (JBPHH), Hawaii, and the 3rd Wing at Joint Base Elmendorf-Richardson (JBER), Alaska. Each wing operates their C-17s using a complement of one active duty and one Air National Guard squadron. The GFMIG also directs an agreement between USPACOM and USTRANSCOM for allocation of the PACAF C-17s, described in the *USTRANCOM-USPACOM C-17 Memorandum of Agreement (2006).*

"Operational Reach is the distance and duration across which a joint force can successfully employ military capabilities. Although reach may be constrained or limited by geography in and around the operations area, it may be extended through forward positioning of capabilities and resources …" (JCS, 2011). Basing directly affects the combat power and other capabilities a joint force can generate. Basing also directly influences the combat power and other capabilities the joint force can generate because of its impact on such critical factors as sortie or resupply rates. However, political and diplomatic considerations can often affect basing decisions (JCS, 2011). Bases are typically selected to be within operational reach of the adversary; however, doing so may place US bases within the adversary's operational reach as well. Planners must strike a balance between supporting the operational and sustainment requirements of assigned and deployed forces and the adversary's likely efforts to deny access to the theater and its infrastructure (JCS, 2011).

Joint Publication 3-17 (JP 3-17), Air Mobility Operations, defines air mobility as "the rapid movement of personnel, materiel, and forces to and from, or within, a theater by air" (JCS, 2011). Rapid global mobility uniquely contributes to movement and maneuver. Air mobility forces enhance other forces' combat power and flexibility. Airlift operations transport and deliver forces and materiel through the air in support of strategic, operational, and/or tactical objectives. Airlift allows deployment of critical early entry force packages over strategic distances without delays caused by terrain or obstacles. Airlift also allows shifting, regrouping, or movement of joint forces within a theater to attain operational reach and positional advantage (JCS, 2011). Intertheater airlift is airlift that transits between one or more geographic commands or theaters. Time-Phased Force and Deployment Data (TPFDD) movements are common examples of intertheater airlift movement. Intratheater airlift is airlift that occurs within a geographic combatant command's theater. Intratheater airlift may include TPFDD and sustainment movements as well as on-demand and routinely scheduled airlift missions (JCS, 2011). Traditional thinking typically aligns C-130s to intratheater movement, however the great distances and large amounts of cargo associated with Pacific airlift have demonstrated the need for C-17s to be utilized in intratheater airlift operations.

Intertheater airland operations normally offload personnel and materiel at main operating locations within the theater. Intratheater airlift is then utilized to distribute personnel and equipment throughout the theater. This employment concept, known as hub and spoke, allows planners to maximize the capabilities of each aircraft type and provide a safe location for transloading operations by avoiding flights into high-threat or contaminated locations (JCS, 2011). This paper reviewed C-17 operations to and from four main operating locations integral to the Pacific's hub and spoke airlift model.

Air Force Doctrine Annex 3-17, Air Mobility Operations, expands on the hub and spoke model discussion, from the airman's perspective.

> Hub and spoke operations integrate both intertheater and intratheater airlift operations. Starting from an aerial port of embarkation (APOE), the movement of cargo and personnel progresses through one or more en route staging bases to arrive at a main operations base (the hub) or aerial port of debarkation (APOD) within a theater. The hub is the focal point for follow-on intratheater airlift missions. Cargo and personnel are processed and readied for transshipment by intratheater assets to forward operating bases (FOB)—the spokes, throughout the theater. The hub and spoke method optimizes air mobility operations when supporting multiple operational commanders and operations. It permits load consolidation to maximize lift capability and allows for transload to specialized aircraft (e.g., landing zone (LZ)-capable, defensive system equipped, smaller aircraft, etc.). This method is comparable to a move that goes from door to central warehouse to door. Intertheater airland operations normally offload personnel and materiel at a main operating location within the theater. Subsequently, intratheater airlift moves designated personnel and equipment to forward operating locations. Units should consider the required MHE and transportation assets needed to transfer personnel, equipment, and cargo from one aircraft to another (LeMay Center for Doctrine, 2013).

Air Force Doctrine Annex 3-0, Operations and Planning, provides in-depth direction on basing, from the airman's perspective:

> Basing and Airfield Suitability: Planners should consider runway and taxiway width, runway length and surface conditions, runway orientation relative to surface weather effects, ramp considerations, pavement weight-bearing requirements, fuel capability, contingency and working maximum on ground (MOG) capacity, availability of aircraft servicing and loading equipment, and many other factors (LeMay Center for Doctrine, 2012).

Annex 3-0 provides a laundry list of concerns for air mobility planners, but those that also apply to basing include additional MOG definitions and requirements at an airfield, threat considerations, airspace control, and host nation support. The research conducted in this paper examines only the main airlift bases which are already in use as part of the Pacific's hub and spoke airlift model, as described in *Annex 3-17*. The basing requirements and concerns described in *Annex 3-0* are not directly addressed in this paper. It is assumed that the requirements and concerns were examined and addressed by DOD and USAF before aircraft were based in those locations.

Asia-Pacific Region

This study reviewed airlift procedures, and the resultant data, as they have been defined for use of the C-17 in the Pacific. These procedures date only to 2006, when C-17s were first based in the Pacific. Therefore, the goal of this section is not to provide a comprehensive review of the history of airlift in the Pacific. However, a short background of the Asia-Pacific region and airlift operations within, and in support of, the region is useful.

The period after the close of World War II has frequently been labeled *Pax Americana* (Latin for "American Peace"), referring to the relative peace in the Western Hemisphere resulting from the preponderance of power possessed by the United States. The underpinnings of *Pax Americana*, as they relate to this study, date back to the late 1800s. In 1867, the US agreed to purchase Alaska from Russia. The Alaska Purchase ended Russia's presence in North America and ensured US access to the northern rim of the Pacific. The US constituted an Alaskan civil government in 1884, and Alaska became a state in 1959 (US Department of State, 2014). In 1893, a small contingent of US diplomatic and military personnel overthrew Queen Liliuokalani's government of the Kingdom of Hawaii. Various attempts at annexation stalled until the Newlands Resolution was signed into law in 1898. Hawaii became a territory in 1900 and, along with Alaska, a state in 1959 (US Department of State, 2014).

US airlift operations in the Pacific date back to the attack on Pearl Harbor. Lacking significant transport capability, the US Army and Navy took control of Pan Am's fleet of seaplanes and their personnel. As World War II progressed, C-47s and C-54s were brought into theater and used extensively in support of the US island-hopping campaigns. In the years to come, the C-119, C-123, C-130, and C-133 aircraft all saw action during the Korea and Vietnam conflicts. The age of the jet engine was ushered into the Pacific when the Military Air Transport Service (MATS) began operating the C-135, a cargo variant based on the Boeing 707. Range and payload drastically increased in the 1960s, with the introduction of the C-141 Starlifter and C-5 Galaxy turbofan-powered aircraft (Owen, 2014).

Pax Americana was characterized by a busy and steady operating environment for US global airlift. In the Pacific, MATS and its successor Military Airlift Command (MAC) were busy knitting together the US base structure scattered across the center of the Pacific as well as the north and western Pacific rim (Owen, 2014). Turbofan airlifters began to be integrated into the large-scale exercises in the Pacific, particularly those exercises in support of the Korean Theater of Operations (KTO), which involved large-scale movements of cargo and personnel (Owen, 2014). In contrast with the European theater, airlift planners in the Pacific did not expect airlifters to operate under threat, with the exception being the small possibility of ground attacks from Special Forces or artillery. Apart from a nuclear exchange with China or Russia, no opponent posed a realistic threat to the Pacific airlift system. Consequently, none of the airlift bases were protected or bunkered against air or ground attacks (Owen, 2014).

In his Pacific Airlift 2020 Assessment paper, Dr. Robert Owen suggests that a competitive peace, or *Pacis Aemulus* (Latin for "Peace Rival), has existed in the Pacific between the US and China since the 1990s (Owen, 2014). Dr. Owen states, "China's rise as an economic powerhouse and regional military power constitutes a direct and intentional threat to the pax [Americana]. China never accepted the pax, seeing it as an unwarranted intrusion into regional affairs and an implied threat to its own sovereign rights, particularly to reunite with Taiwan" (Owen, 2014). China has focused on the improvement of its Anti-Access/Area-Denial (A2/AD) capabilities, and it is these burgeoning capabilities that threaten to make life uncertain for US airlift operations in the

Pacific. "By 2020, airlift forces operating at all western Pacific US bases in a major regional conflict will be subject to robust and persistent attack. By that time, China's current force of 1,500-1,700 short-range ballistic missiles and cruise missiles may have doubled in numbers and gained precision accuracy" (Owen, 2014). In light of China's improving capabilities, airlifters on the ground at forward airfields will be most vulnerable. Due to their size, airlifters cannot be placed into hardened shelters or parked randomly. Airlifters also tend to sit in one place for a long period of time while accomplishing uploads and/or downloads. As with any other military asset, dispersal of the ground operations will reduce the threat. Dispersal comes in direct conflict with the hub and spoke operations concepts; dispersal will no doubt result in reduced throughput and efficiency. This study is based upon the latter and not the former; if airlift forces are aggregated to improve efficiency, a contingency dispersal plan must be created.

The sustainment requirement for US forces in the Pacific is expected to rise. Increases in rotational deployments and an increased engagement program will be the likely drivers. For example, the US Marines have established a rotational presence at Darwin, Australia, which will drive the need for additional support (Owen, 2014).

On April 28, 2014, President Obama and President Aquino (Philippines) announced that the two countries agreed to an Enhanced Defense Cooperation Agreement (EDCA). The EDCA updates and strengthens US-Philippine defense cooperation to meet 21st century challenges. The agreement will facilitate the enhanced rotational presence of US forces; facilitate humanitarian assistance and disaster relief in the Philippines and the region; improve opportunities for bilateral training; and support the long-term modernization of the Armed Forces of the Philippines (AFP) as it works to establish a minimum credible defense (The White House, 2014). Increasing rotations to, and exercises with the Philippines will no doubt further burden the Pacific airlift system.

In addition to increased rotational deployments, the Pacific "Ring of Fire" is likely to keep airlifters busy. The US cultivates trust and relationships in the region by conducting Humanitarian Assistance / Disaster Relief (HA/DR) operations in response to the frequent natural disasters. These HA/DR operations create conditions for deep engagement with regional partners and allies in a way that enhances communication and builds trust. HA/DR operations also allow the US to maintain presence and posture forces, particularly airlift, in order to rapidly react to such crises. Efforts to position airlift assets, as well as search and rescue assets, enable the USAF to develop working relationships with potential and future partners. These efforts may also give the US access to basing and ensure pre-positioning of the assets most crucial at the onset of a crisis, and enable the US to work for peace while simultaneously hedging its bets against all possible outliers (Hayden et al., 2013).

The increasing number of engagements will also drive airlift requirements higher. USPACOM has been increasing its engagement programs, focusing its efforts particularly on Southeast Asia. In light of declining resources, building partnerships based on mutual benefit reflects smart defense. Partnerships ensure interoperability and integration of military forces, thus benefiting regional security. The expanding growth and rising influence of the Association of Southeast Asian Nations (ASEAN), a political and economic organization consisting of ten nations, has led to increased regional stability. ASEAN Plus Three has brought China, South Korea, and Japan into the fold, and bilateral agreements between these three countries and ASEAN may lead to further easement of territorial disputes in the East Asia region. Trilateral accords between Japan, South Korea, and the US, as well as Australia, Japan, and the US will also prove useful. Because interoperability exists between those nations, the military exercises with these nations (e.g. RIMPAC, Talisman Saber) continue to prove successful (Hayden et al., 2013).

Rapid global transport in the Asia-Pacific region is essential to the JFC's ability to conduct operations and build US regional influence, which contributes to attaining the desired end state. Airlift offers vital support to deterrence, and helps establish influence by providing disaster relief to regional nations in need. Current and potential regional partners could benefit from USAF's knowledge in the airlift arena; in addition, nations are more inclined to grant access to global transport aircraft (Hayden et al., 2013).

Basing & Structure

In 1999, the Pacific En Route Infrastructure Steering Committee (PERISC) established what has become known as the 2-lose-1 strategy - basing along two primary Pacific routes with sufficient capacity to permit the temporary loss of one route without excessively delaying the delivery of forces along the other. The Mobility Requirements Study-2005 (MRS-05) and Mobility Capabilities Study (MCS) refined the requirements, and MRS-05 became the justification for a large number of improvements in the Pacific theater. The MCS stated that the overseas infrastructure, not the number of available aircraft, remains the fundamental constraint when attempting to reduce delivery timelines associated with large scale deployments (AMC, 2009).

The Northern Pacific route more closely follows great circle routing from the Continental United States (CONUS) to the Korean peninsula and China Sea areas, making it more fuel efficient. Typical stops include locations in Alaska and Japan, meaning poor winter weather can sometimes wreak havoc. Locations in Japan are also under a greater threat from adversarial action. The Southern route, consisting of stops in Hawaii or Guam, is far less fuel efficient but typically experiences more favorable weather. For the most part, Hawaii is not under threat from an adversary, while some weapons can range Guam. With C-17s assigned, JBER and JBPHH are both at AMC Tier I status for en route support, meaning they possess both major maintenance capability as well as full hub-and-spoke distribution aerial port capability (AMC, 2009).

When assessing global USAF basing, the Air Force Research Institute (AFRI) deemed Korean Security and the Japanese Alliance as “Major Interests.” Major Interests are defined as “those interests that - while important - are not worth waging war to defend” (Hagel, Lowther, & Dacus, 2010). While mutual defense treaties between the US and both countries exist, and the US remains committed to the security of each country, the current rationale for the continued presence of forces in Korea and Japan is premised on deterring a rising China (Hagel, Lowther, & Dacus, 2010). Due to its central location in the west Pacific rim, Japan also represents a strategic node for air mobility operations. Airfields in Japan are part of both the Northern and Southern routes, and Japan is frequently used as a hub for further distribution into Southeast Asia and Oceania.

Currently, there are four en route locations in Japan - Misawa Air Base (AB) in the north; Yokota AB in the middle of Honshu, near Tokyo; Marine Corps Air Station (MCAS) Iwakuni in the south of the Honshu; and Kadena AB on the southern island of

Okinawa. Operations on any of these bases encounter significant positives and negatives. Yokota and Kadena possess the greatest throughput of cargo and passengers. However, expansion at either, due mostly to their proximity to large civilian populations and obstructions, would be challenging. At both Misawa and Iwakuni, mobility operations are not the primary missions. Iwakuni represents an excellent multi-modal location - similar to Naval Air Station Rota, Spain, Iwakuni has a deep-water port attached to the base. However, Iwakuni lacks runway and parking infrastructure to support large-scale mobility operations (AMC, 2009). As an additional benefit, Japan is the worldwide leading provider of host nation support to US military forces. As of 2007, Japan was providing 74% of the required funding to support US installations in Japan. In contrast, South Korea and Germany provided 40% and 33% host nation support, respectively, during the same time period (Hagel, Lowther, & Dacus, 2010).

The main operating base in Guam can also support US power projection in the region. However, Joint Base Marianas, which includes Navy Base Guam and Andersen AFB, cannot support all of the assets required for major operations in the region. The use of installations on Guam would typically occur in conjunction with the use of Okinawa or, with the new EDCA in place, the Philippines. The proximity of these locations to the South China Sea, the Straits of Malacca, and the region's oil resources is desirable (Hagel, Lowther, & Dacus, 2010).

C-17 Application

With the multitude of mobility studies occurring in the late 1990s and early 2000s, one might think the assignment of C-17s to bases in the Pacific was based upon a strategic need or requirement within an operations plan. In reality, C-17 basing outside of Charleston AFB, McChord AFB, and Altus AFB was driven by politics. When the USAF notified Congress in 1995 of its intention to grow its C-17 fleet at the three primary operating bases, members began to question the plan. Representatives from California (Travis AFB) and New Jersey (McGuire AFB) questioned if their C-141s were going to be replaced. Senator Ted Stevens of Alaska, long a staunch supporter of the C-17 through its budgetary trials, voiced an interest in having C-17s at Elmendorf AFB. When the Air National Guard disclosed its plan to base C-17s in Mississippi, more questions were asked in the Senate. Senator Joseph Biden of Delaware and Senator Daniel Inouye of Hawaii pressed for C-17s in their state. When the USAF countered that they did not have enough C-17s to spread amongst those locations, Congress responded by adding more C-17s to the budget, increasing the planned buy from 120 to 180 in late 2001. Increased military activity in response to the September 11, 2001, attacks also drove the interest for more C-17s. In April 2002, USAF released its plan for the basing of 180 C-17s, with eight (8) C-17s assigned to Hickam AFB, HI, and eight (8) C-17s assigned to Elmendorf AFB, AK (Kennedy, 2004). All 16 C-17s are under the COCOM authority of USTRANSCOM, while OPCON rests with USPACOM. Each wing of eight C-17s allocates four aircraft to missions tasked by USTRANSCOM and coordinated by USPACOM and PACAF (USTRANSCOM/USPACOM, 2006).

With the range and payload capability of a strategic lifter, and the short and austere field capability of a tactical lifter, the C-17 is an excellent fit for the Pacific theater. Distances and required payloads in the Pacific theater have increasingly made operations unsuitable for C-130s. In many possible Pacific scenarios, the operational radii, not their actual range, are a better indication of an aircraft's utility. Both the C-17 and C-130 would have to operate at a fraction of their capacities to transit a number of routes typical to the region. C-130s are only marginally capable of moving cargo and passengers from Hawaii to Guam or Japan. C-130s are best suited to local distribution operations, such as that required between Japan and Korea during a Korean peninsula conflict scenario (Owen, 2014).

Assigning C-17s to PACAF made strategic sense in a lot of ways, but assigning them to Hawaii and Alaska was driven by politics. The high cost of positioning aircraft to/from Hawaii - between both CONUS and the western Pacific - has become an issue amongst PACOM component commands. Establishing a rotational deployment of a few C-17s and/or C-130s in the theater during busy exercise periods would reduce positioning costs and provide excellent training for aircrew (Owen, 2014).

In 1998, PACAF commenced Operation VOLANT SHOGUN, which deployed C-130s from Elmendorf AFB, AK, to Yokota AB, Japan. This operation occurred before C-17s were assigned to the theater, and was the result of the higher demand for airlift at Yokota when compared to Elmendorf. Operation VOLANT SHOGUN deployed up to three C-130s and four crew to Yokota in support of peacetime requirements. Missions were still being cancelled due to a lack of aircraft (Bauer, 2000). Similar operations could be conducted today, moving both C-17s and C-130s from their permanent homes to the locations that need their services the most. Shrinking budgets will require creative solutions such as those found in Operation VOLANT SHOGUN.

III. Methodology

In order to examine the Pacific's current airlift structure, AMC's Operational Integration and Analysis Branch (AMC/A3RI) was enlisted to provide all mission data on every C-17 mission in the Pacific in the calendar years 2006-2012. The data is provided from Mobility Air Forces Operations Decision Support System (MODSS) Data Warehouse within the 618 AOC (TACC) Data and Web Services and Airfield Suitability Report. The 618 (AOC) TACC Data Warehouse integrates source system data from many disparate systems. MODSS contains data from Military Flight Operations Quality Assurance (MFOQA), Global Decision Support System (GDSS), Advanced Computer Flight Plan (ACFP), Global Air Transportation Execution System (GATES), Aircraft Communications Addressing and Reporting System (ACARS) and the web-based Fuel Tracker (FT).

The MODSS database tracks and stores every mobility aircraft and its associated missions. Each data line denotes a single sortie, or flight leg, of a mission. A sortie is comprised of a takeoff from a departure location, and a landing at an arrival location. A mission is comprised of multiple sorties. Each sortie line includes a significant amount of data: mission number, Julian-calendar date, aircraft tail number, aircraft owning / operating unit, departure location, arrival location, departure time, arrival time, total flight time, and mission class (e.g. contingency, channel, training). The mission number (or mission ID) itself has twelve characters; each holds a specific meaning: operating unit, mission type, Julian dates, etc. The *MAF Mission ID Encode/Decode Procedures (2009)* document, published by Air Mobility Command, provides an explanation of the Mission ID composition:

2.1. Mission ID Composition. Mission numbers are twelve characters in length. Depending upon the category mission supported, a mission number is normally broken into four parts:

2.1.1. Prefix. The first three characters comprise the prefix.

2.1.1.1. Mission ID First Character**.** The first character defines the command or agency having operational control (OPCON) or tactical control (TACON) over the mission.

2.1.2. Basic Mission Number. The basic mission number is the fourth through seventh characters. The encryption of these characters varies depending on the mission type.

2.1.3. Suffix. Eighth and ninth characters. For most missions, identifies the sequence number for multiple missions departing on the same Julian Date.

2.1.4. Julian Calendar Date. The tenth through twelfth characters comprise the Julian calendar date of scheduled origin.

(Air Mobility Command, 2009)

The data set utilized represents all US Air Force C-17 missions flown in calendar years 2006 through 2012 in which at least one departure or arrival occurred at PHIK or PAED. A small number of missions were excluded because they contained incomplete data. The data set that remained - and that which was used - consisted of 6,420 C-17 sorties. Each sortie had a *City Pair* column assigned, in which the departure and arrival locations made up the city pair. GDSS historical data was used to determine C-17 flight times between each city pair.

Each sortie was then recalculated, using the historical city pair flight times, by exclusively replacing PHIK or PAED with four test locations: PHIK, PAED, KSUU, and RJTY. This process resulted in newly-generated C-17 sorties for each of the four test locations; four new subsets of data each totaling 6,420 sorties. Specifically, one subset was those new sorties where every occurrence of PHIK and PAED was replaced with only PHIK. The second subset was those new sorties where every occurrence of PHIK and PAED was replaced with only PAED. The third subset was those new sorties where every occurrence of PHIK and PAED was replaced with only KSUU. The fourth subset was those new sorties where every occurrence of PHIK and PAED was replaced with RJTY. The goal of the location replacement process was to generate a new subset of data points for each of the four test locations. These new subsets reflected what the sorties would look like if only that given location were available for C-17 operations. At the end of the calculation / re-calculation process, five subsets of data remained, each with 6,420 separate sorties, for a total sortie count of 32,100 individual sorties. These 32,100 sorties represent the entire data set.

Data filtering was a requirement in order to effectively analyze the results. The most basic filter utilized was to filter each data subset by year. When an annual comparison is presented, the year depicted represents sorties commenced within the stated calendar year.

The second filter performed on the subsets was one that eliminated all C-17 owning organizations (OWN_ORG) except 3rd Wing (PAED) and 15th Wing (PHIK) aircraft. By doing so, the new subsets of data depict only the C-17s that are assigned to PACAF. This filter enabled an additional analysis to be conducted as if all of the C-17s currently assigned to PACAF were based at only one location, instead of being split between PAED and PHIK as they are currently. This filter was applied to each of the four location subsets and analyzed.

The final filter utilized was to filter the sorties by mission class (MSN_CLASS). Each sortie was categorized by their respective mission planners into one of 17 mission classes: Airevac (evacuation), Airshow, Channel, Contingency, Exercise, FCF (Functional Check Flight), Guardlift, Hurrevac (hurricane evacuation), JAATT (Joint Airborne Air Transportability Training), ORI (Operational Readiness Inspection), Refuel, SAAM (Special Assignment Airlift Mission), SAM (similar to SAAM), Special, Support, Training, and Transfer. In order to examine only the data that would change if the aircraft were re-located, the mission classes that would normally remain near the base, e.g. Training, Airshow, and FCF flights, were filtered out. Also, Guardlift and Hurrevac were filtered out, as they represent mission classes that would be fundamentally altered if the C-17s were to change base(s) of operations.

In the end, eight mission classes were filtered out when comparing the new location sortie subsets. The nine mission classes remaining for the side-by-side comparisons were Airevac, Channel, Contingency, Exercise, JAATT, SAAM, SAM, Special, and Support. These nine missions classes were chosen to remain in the calculations because it was assumed that these missions and associated destinations would continue unchanged no matter where the aircraft operated from. For example, as part Exercise Cope Tiger, the C-17s would travel to Thailand to participate no matter where they are based. Likewise, if involved in a JAATT at an Alaskan training facility, the C-17s would likely travel to PAED no matter where they are based.

IV. Analysis and Results

The first analysis conducted was on the flight time differences between the five subsets of data, and included all C-17 sorties which had an arrival or departure at either PHIK or PAED. Each of the four new subsets depicted what operations would have looked like, had only that base been available for C-17 operations. The four new subsets were compared against the original subset of data, the actual C-17 sorties flown in 2006-2012 that operated in or out of PHIK or PAED. By isolating each base in the data, a new norm is created that can be compared to the other new norms. In Figure 1, the differences in flight time for each of the four new subsets are represented. They are compared against the original subset of data, the actual sorties flown. A positive number (above the horizontal axis) represents a reduction (savings) in flight time when compared to the actual sorties flown. For example, if all C-17 sorties had operated in and out of RJTY instead of PHIK and PAED, the USAF would have realized a savings of 7,326 flight hours over the six-year period examined. In comparison, if all C-17 operations were conducted into the other three airfields, with no mission adjustments, USAF would fly more hours than were actually flown: 1,508 with PAED-only operations, 13,567 with PHIK-only operations, and 26,757 more with KSUU-only operations.

The data depicted in Figure 1, however, may lead to incorrect conclusions. In reality, the missions would not be conducted identically if the USAF was forced to operate out of only one location. Mission filtering was required to gain a more accurate picture of the new norms. The primary misleading examples were given in Section III, Methodology: missions like training, which typically remain near the home base, would be flown differently. The depicted data was skewed because it does not remove these anomalies. In order to accurately depict the missions that would likely not change, or would change only slightly, the data filtration process described in Section III was accomplished.

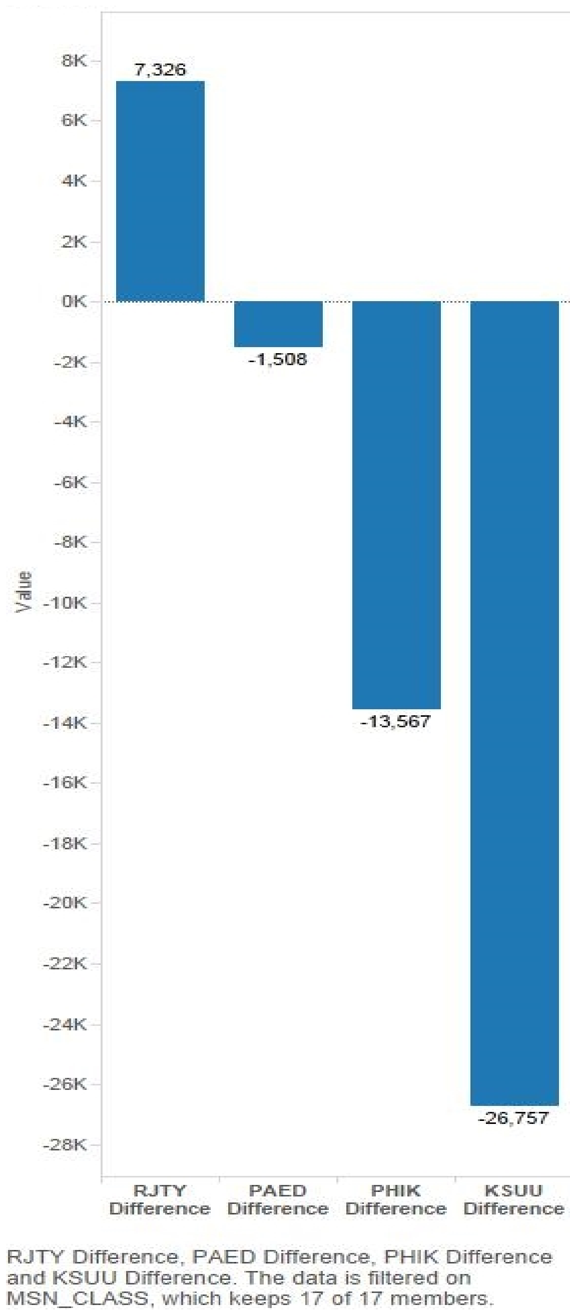


Figure 1. Unfiltered Flight Differences

Figure 2 depicts the differences in flight time between the four new subsets of data and the actual flight times flown with the non-mission classes filtered out. The nine mission classes remaining for the side-by-side comparison are Airevac, Channel, Contingency, Exercise, JAATT, SAAM, SAM, Special, and Support. For each of the four locations, Guardlift and Training represented the largest negative flight difference, and this is a logical outcome. For example, the process of re-calculating city pairs would result in the creation of a training mission, which actually flew from PHIK to another airport within the Hawaiian Islands, to instead appear as if it flew from PHIK to RJTY and back to PHIK. A flight of this nature would not be planned on a local training mission. Likewise, Guardlift missions are also commonly flown from PHIK to other destinations within the Hawaiian Islands. The re-calculation process entered artificialities into the comparisons; hence, these types of missions are filtered out in this chart.

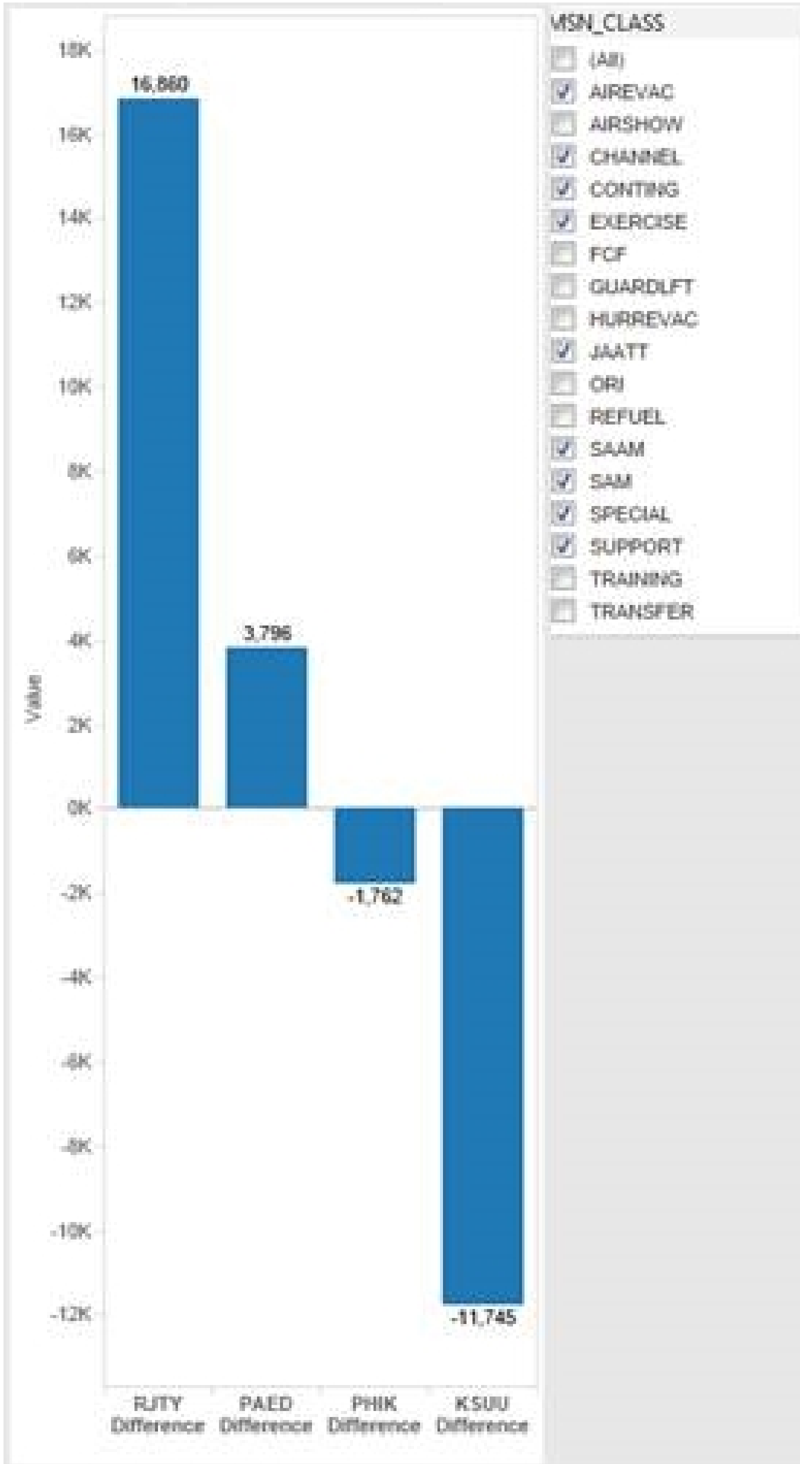


Figure 2. Filtered Flight Differences

After the filtration, it becomes clear that great savings in flight time would be realized if missions were operated exclusively out of RJTY. The savings would be in the flight time charged to TWCF accounts, meaning the savings would be for the greater good of all DOD users. Based upon the FY14 hourly rate for aircraft on TWCF missions of $14,523 per C-17 flight hour (USTRANSCOM, 2014), a reduction in flight time of 16,860 hours over a six-year period would represent a savings to the DOD of almost $245 million. At the other end of the spectrum, if the C-17s had operated exclusively out of KSUU, yet accomplished the same missions, they would have flown 11,745 more flight hours at a cost to the DOD of over $170 million.

In addition, if the flight differences are filtered to the nine wartime Mission Classes as well as only 3rd Wing (PAED) and 15th Wing (PHIK) aircraft, the chart in Figure 3 depicts what the flight time would have been had all PACAF C-17s been assigned to a single location. If they were all based at RJTY, there would have been a flight savings of 5666 hours. If based at PAED, there would have been a flight time savings of 2430 hours. If the aircraft were all based at PHIK, an additional 1699 flight hours would have been expended. Finally, if the aircraft were all based at KSUU, an additional 5721 flight hours would have been expended.

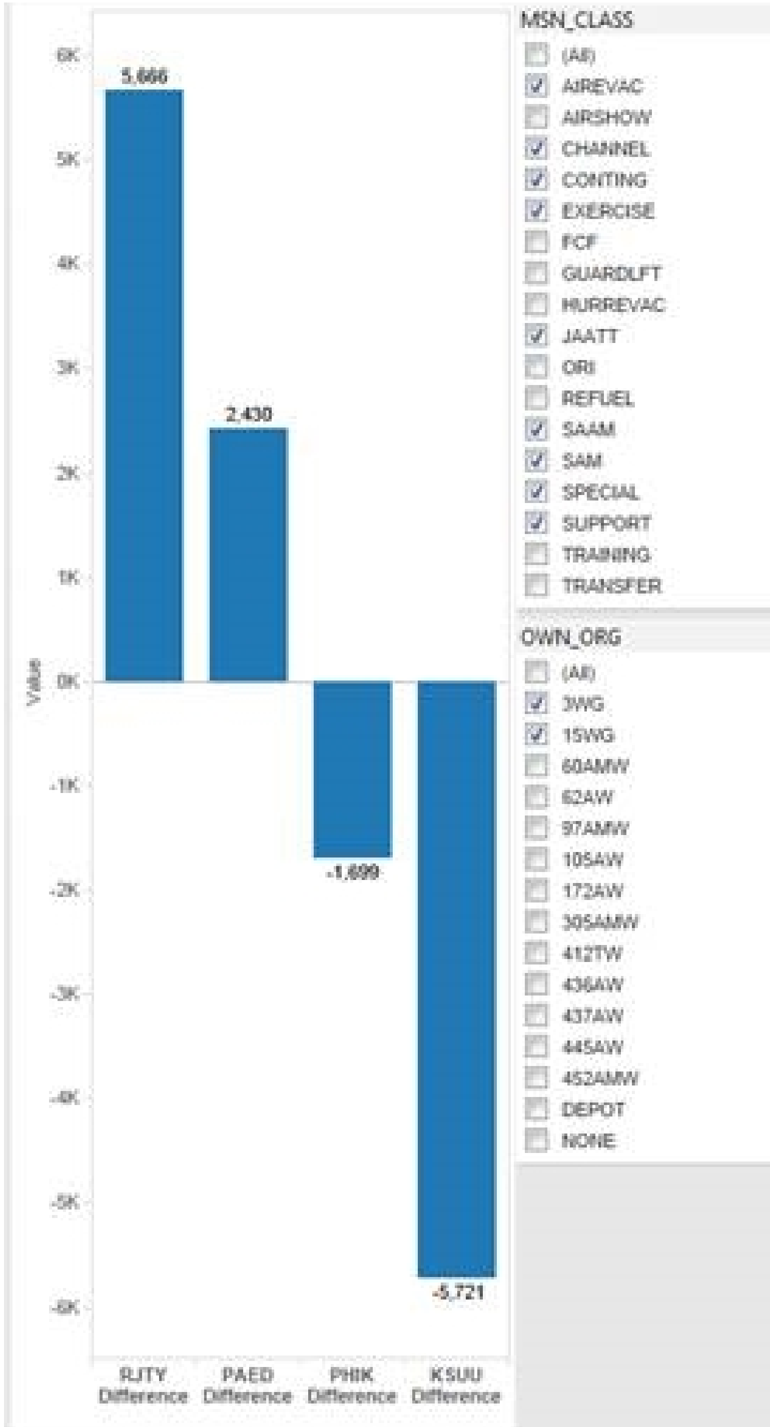


Figure 3. Filtered Flight Differences (3WG/15WG)

When broken out by year, as is depicted in Figure 4, the annual results mirror the six-year combined results. Each year, C-17 operations exclusively out of RJTY, when compared to what missions were actually flown, would have resulted in less mission flight hours expended. The peak flight time savings for RJTY would have been 2012, with a savings of 3,145 hours, or $45.7 million at the current C-17 hourly rate. The most overage of flight time would have occurred in 2008 if all C-17s had operated exclusively out of KSUU. The overage of time in that instance would have been 2,102 hours, or an additional $30.5 million spent at the current hourly rate. Operations exclusively out of PAED would have resulted in some flight time savings, while operations exclusively out of PHIK would have resulted in some flight time additions some years, and some savings in others.

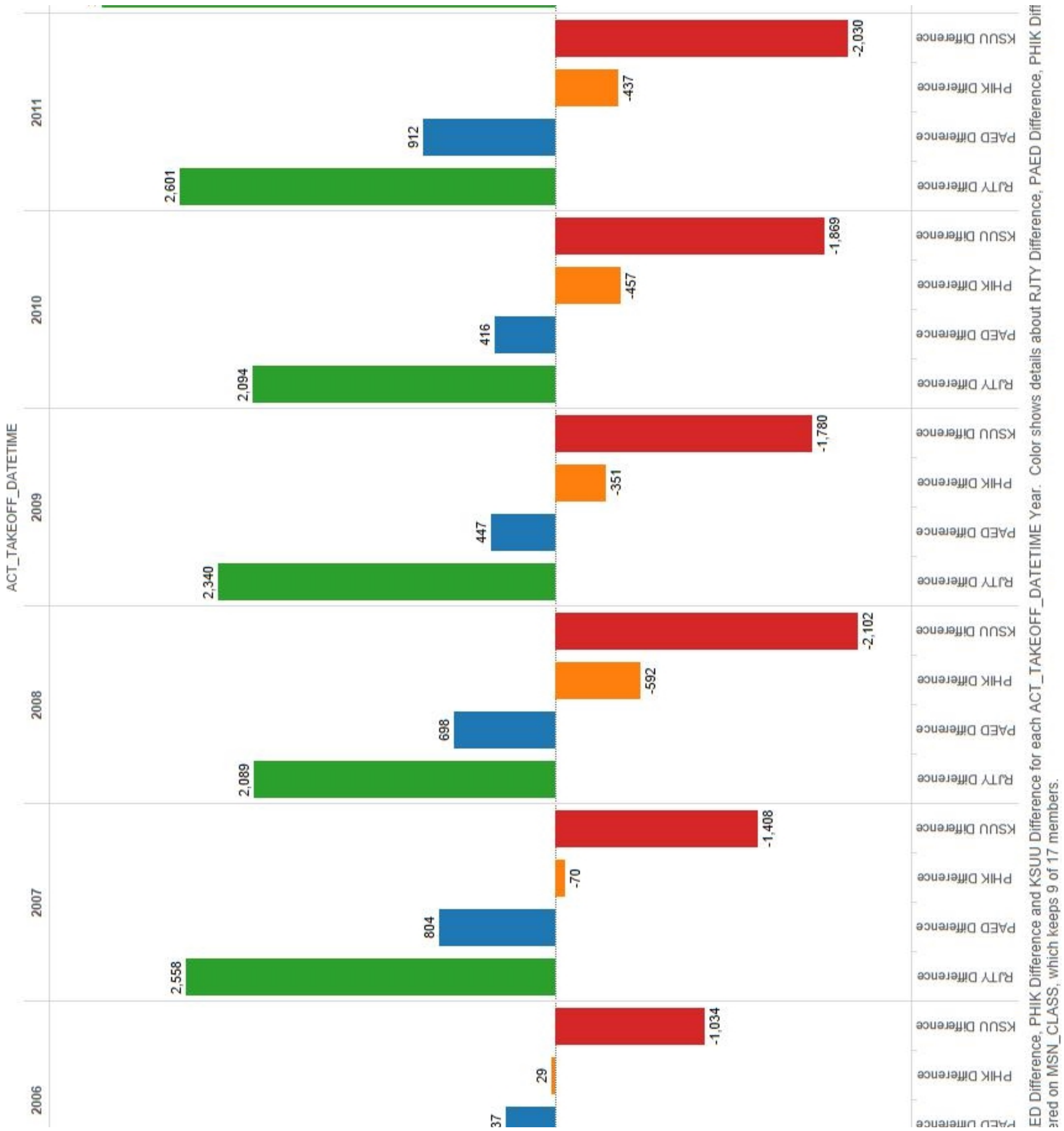


Figure 4. Filtered Flight Time Differences by Year

Further expanding upon the Mission Class, Figure 5 depicts the breakout of all 17 Mission Classes found in the GDSS data. This chart represents a sum of the six years of data for all USAF C-17s which have operated in the Pacific, and is again a comparison of each of the four airfields (new norms) against the actual flight time flown. Positive numbers (above the horizontal axis) represent flight time savings when compared to the actual missions flown, and negative numbers (below the horizontal axis) represent additional expenditure of flight time. In all four scenarios, there are five Mission Classes that stand out, reflecting large differences from the actual missions flown: Channel, Contingency, Guardlift, SAAM, and Training. For all four subsets, Guardlift and Training are negative. As previously explained this is logical and expected as those two mission sets typically remain near the C-17's home station. By artificially requiring the C-17 to fly to a new location before returning to its home station, the calculations skewed the data. Hence, Guardlift and Training are filtered out in the primary comparisons. The three primary Mission Classes that might depict the actual wartime requirements are Channel, Contingency, and SAAM. Exclusive operations at RJTY would save the USAF flight time in all three categories. Exclusive operations at PAED would save the USAF in Channel and Contingency, while adding some time back in the SAAM category. Exclusive operations at PHIK offers minimal differences, with some flight time savings in the Contingency category, and some additions in the Channel and SAAM category. Finally, exclusive operations at KSUU would result in additional flight time expended in all three categories.

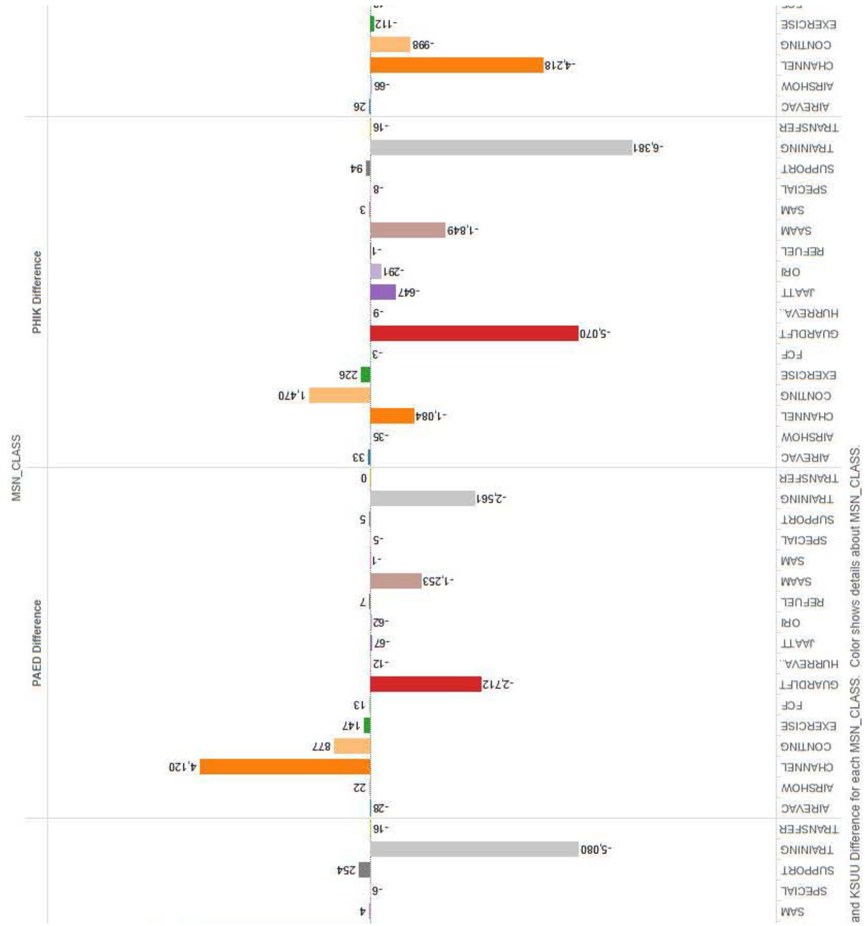


Figure 5. Mission Class by Base

Figure 6 depicts the breakout of all 17 Mission Classes found in the GDSS data. However, this chart represents a sum of the six years of data for only PACAF C-17s, that is, only those that are permanently assigned to PHIK or PAED. This chart also depicts a comparison of each of the four airfields (new norms) against the actual flight time flown. Essentially, this chart represents new norms in which all PACAF C-17s would be based exclusively at one of the four airfields depicted. As previously seen, the three primary wartime mission categories (Channel, Contingency and SAAM) would all experience savings if the C-17s operated exclusively out of RJTY. PAED again reflects savings in the Channel and Contingency categories, with some additional expenditure in the SAAM category. Operations out of PHIK exclusively would result in some savings in the Contingency category, while operating out of KSUU exclusively would result in more flight time expenditures in all categories. Also of note on this chart is the JAATT category. With the exception of PAED, operations out of the other three airfields would add flight time requirements in the JAATT category. JAATT missions commonly operate to/from PAED, regardless of where the aircraft are based, therefore this outcome is logical.

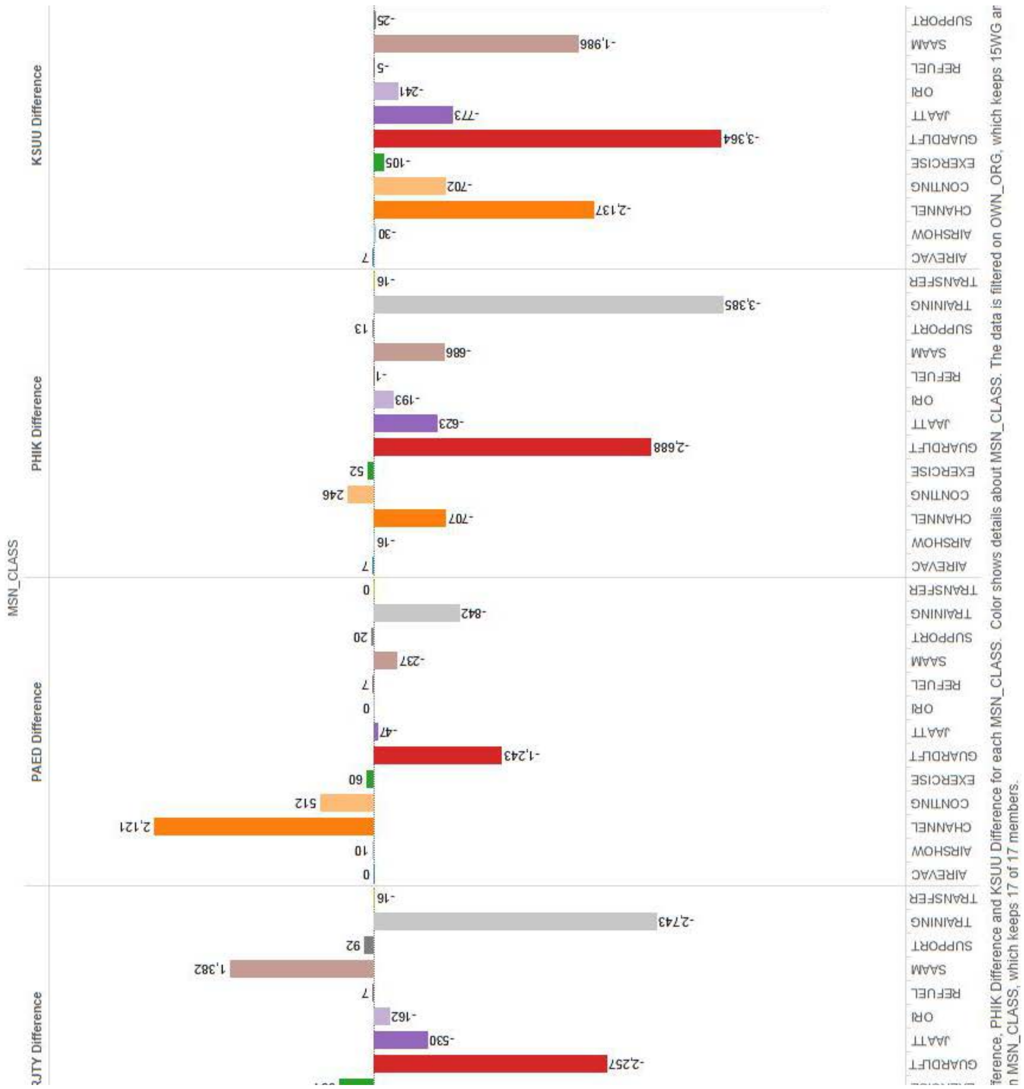


Figure 6. Mission Class by Base (3WG/15WG)

Figure 7 and Figure 8 provide a baseline of data for C-17 operations in the Pacific. Both show an overall increase in C-17 flight operations in the Pacific. When compared, the two Figures also show that since 2010, PACAF C-17s have carried an increasing share of the Pacific C-17 workload. PACAF C-17s carried roughly 30% of the workload in 2009. That number had doubled by 2012, with PACAF C-17s carrying roughly 60% of the Pacific C-17 workload in 2012. Overall, Pacific Channel and SAAM operations have remained relatively constant; however, PACAF C-17s have increased the share of the Channel and SAAM workload since 2009. Contingency operations in the Pacific have more than doubled since 2006, and PACAF C-17s carried 58% of the Contingency workload in 2012.

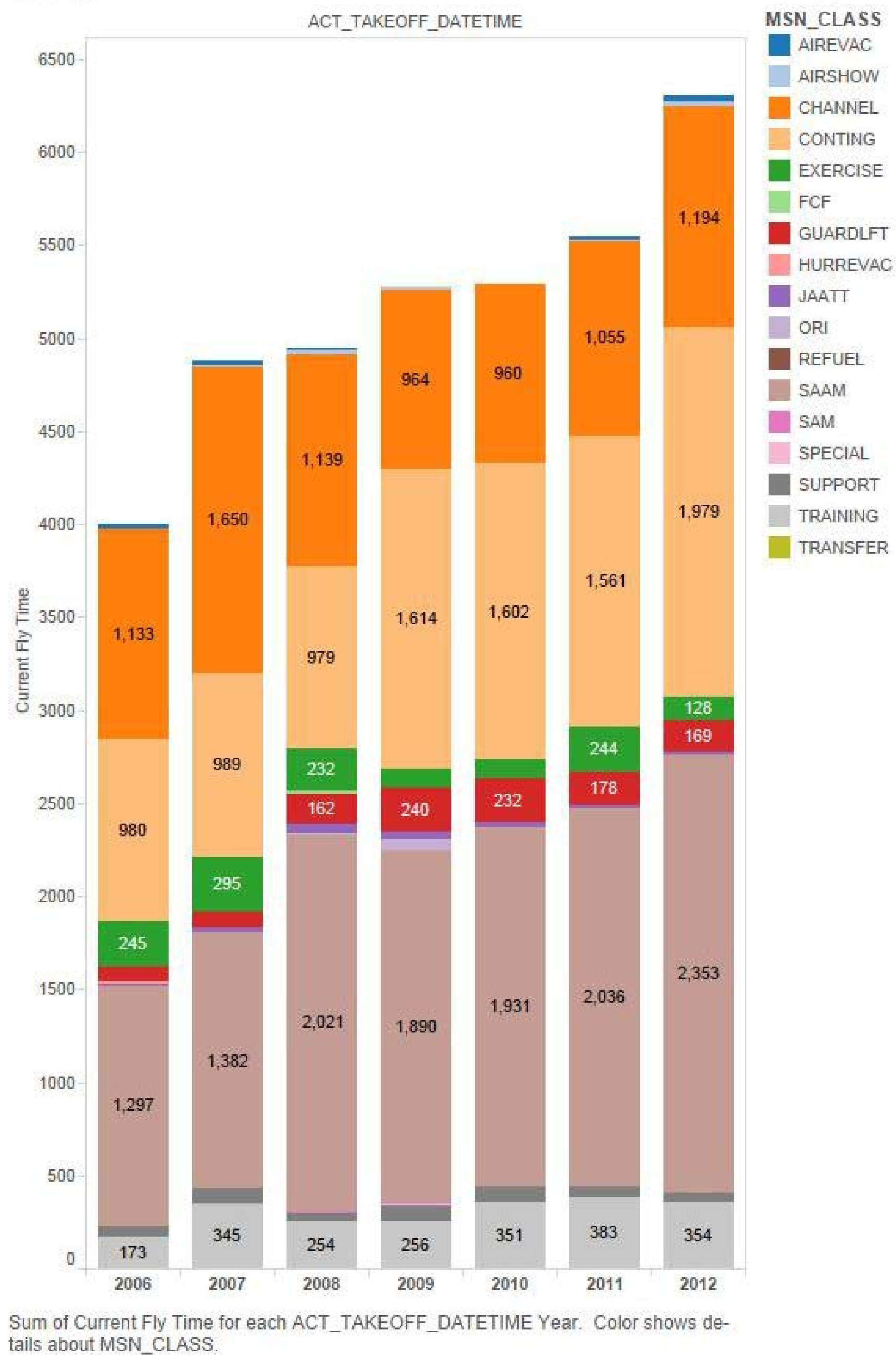
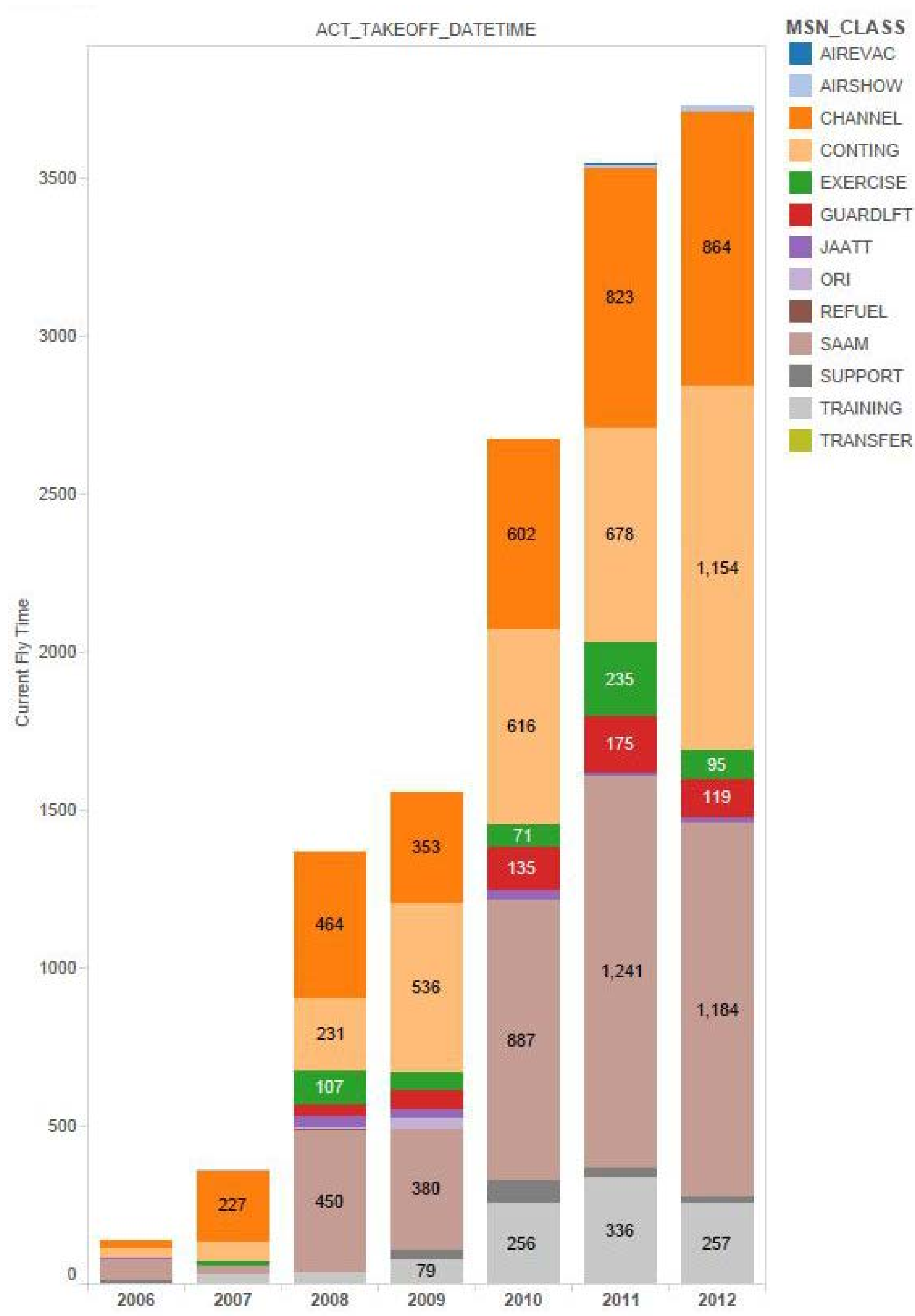


Figure 7. Total Hours Flown by Mission Class



Sum of Current Fly Time for each ACT_TAKEOFF_DATETIME Year. Color shows details about MSN_CLASS. The data is filtered on OWN_ORG, which keeps 15WG and 3WG. The view is filtered on MSN_CLASS, which keeps 17 of 17 members.

Figure 8. Total Hours Flown by Mission Class (3WG/15WG)

Figure 9 depicts a breakout of total flight time, by year, for the four new subsets of data. These four new norms are the re-calculations of C-17 sorties flown exclusively out of a single location. This chart depicts only the nine wartime Mission Classes; the other eight Mission Classes are filtered out. Unlike previous figures, this chart depicts what the total flight times would have been for each scenario, not differences from the actual flight times flown as the previous Figures have depicted. Without question, total flight time would have been less each year if operating exclusively from RJTY. This chart also reflects a trend that the Pacific missions have moved southwesterly since 2008, when the total flight time stabilized. PAED saw the steepest rise in calculated total flight time since 2008, a gain of 47%. PHIK and KSUU both rose by 11%, while RJTY only rose 8%. This would indicate that the last four years of missions in the data set have remained focused about the RJTY-PHIK region, i.e. the first and second island chains of the Pacific.

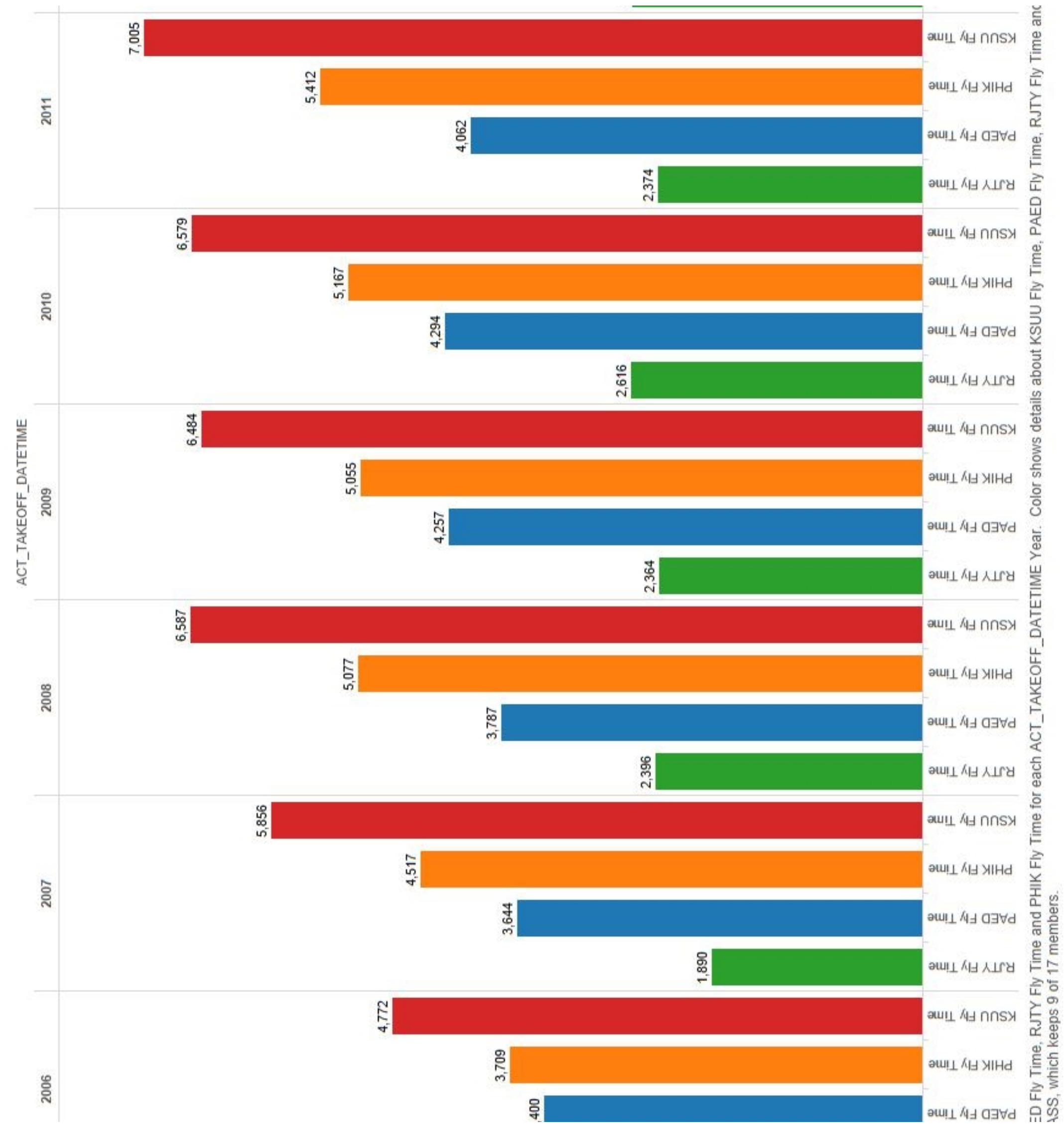


Figure 9. Flight Time by Year

As in Figure 9, Figure 10 depicts total flight time for each of the four norms. In this chart, however, the total flight time is depicted in a stacked bar chart, broken out by all 17 Mission Classes. This chart indicates that while the mission focal point appears to be moving in a southwesterly direction - recall that exclusive operations at PAED would have seen the largest increase in total flight time by percentage - the spread amongst the varying classes of missions hasn't varied largely since the Pacific C-17 operations stabilized in 2008.

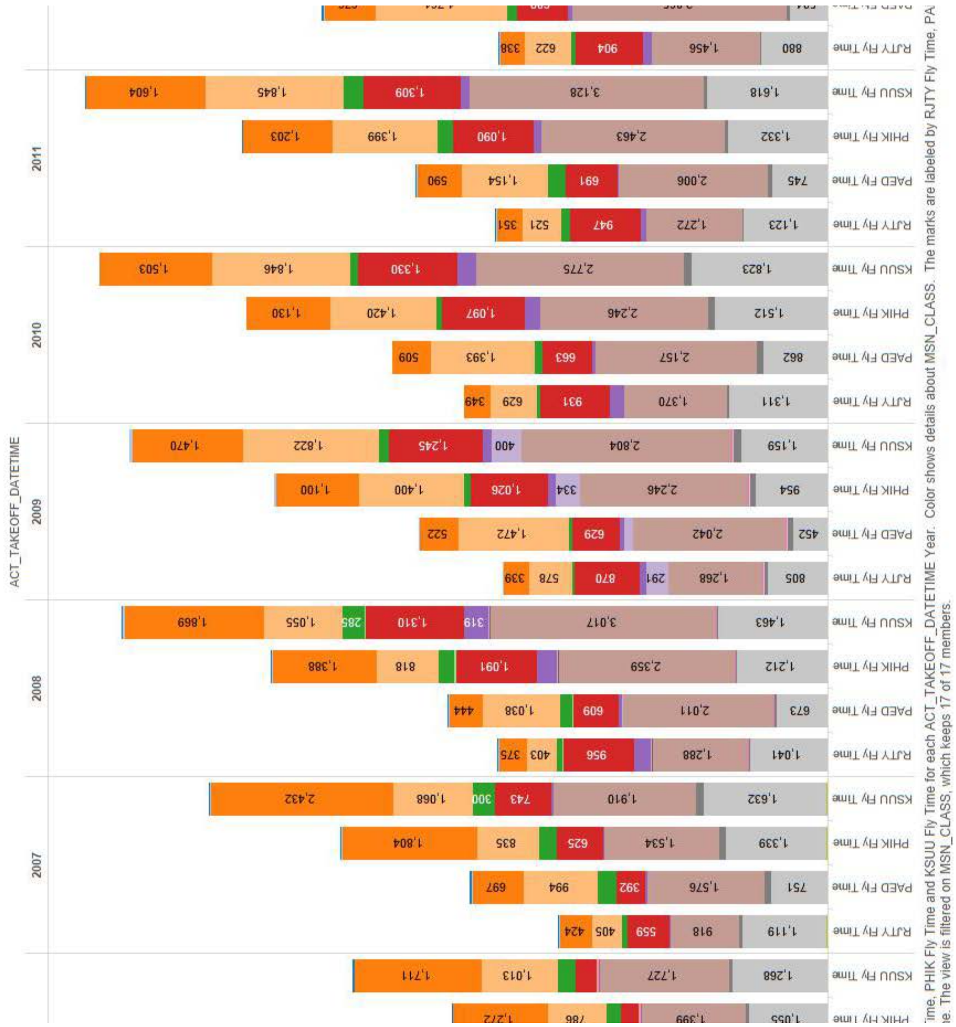


Figure 10. New Missions Total

Figure 11 depicts the total flight time for each of the four new norms as well, but with all but PACAF C-17s filtered out. In general, this chart represents the increasing focus on the Pacific region, and in response, the increased use of the PACAF C-17s. After the re-calculations, flight time for the Channel and Contingency categories increased for all airfields except RJTY. Also, as discussed earlier, the Guardlift and

Training flight time categories are higher at RJTY and KSUU when compared with PAED and PHIK. Because Training and Guardlift missions are typically conducted at or near the home station, moving the aircraft away from home station artificially increases those categories.

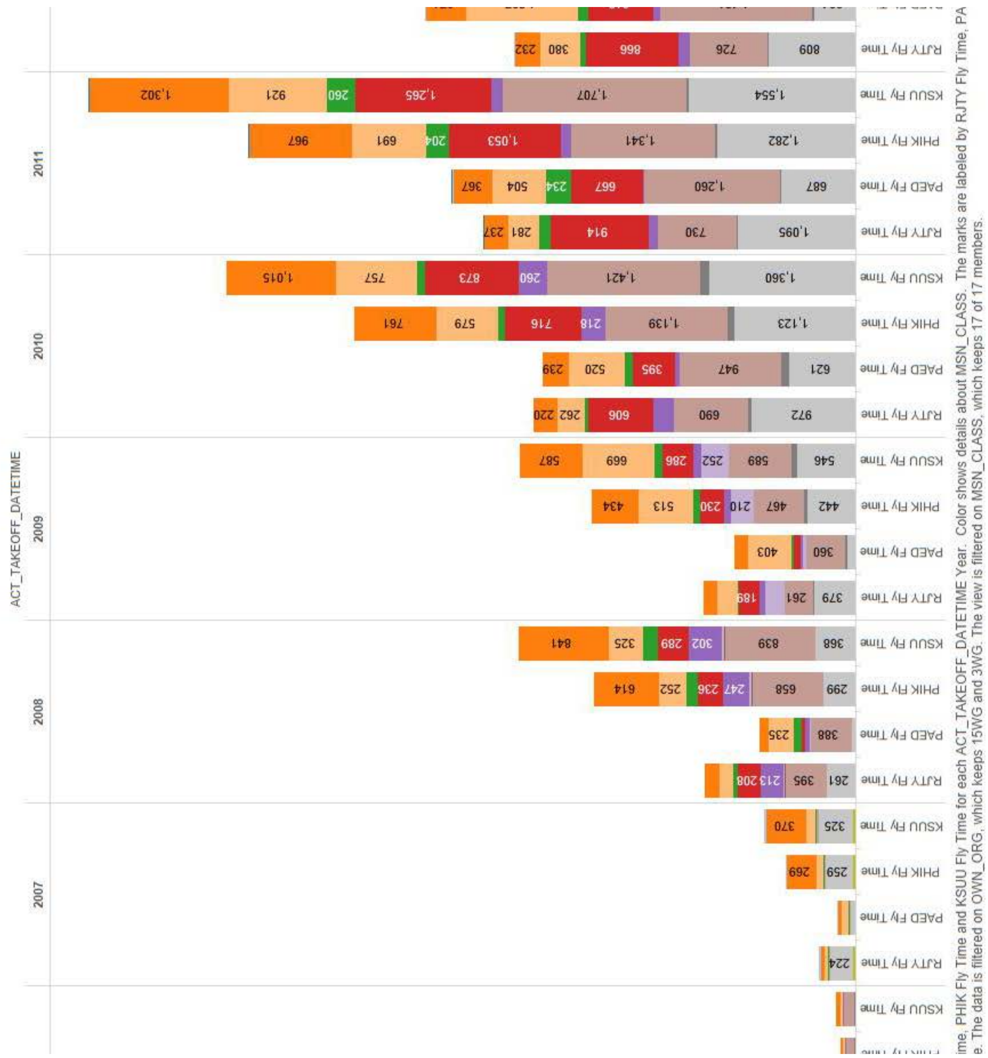
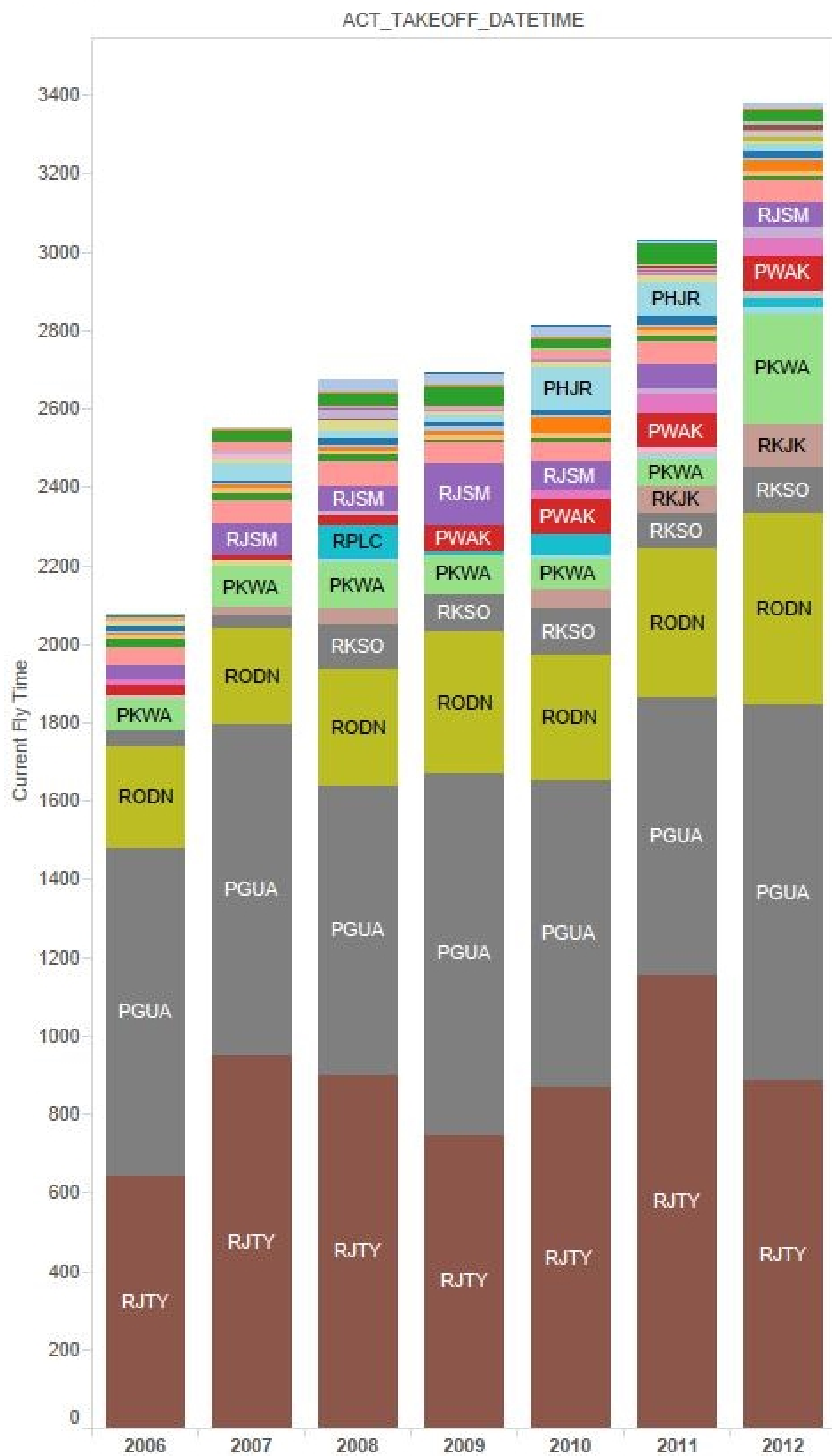


Figure 11. New Missions Total (3WG/15WG)

To further examine the apparent shift in focal point to the southwest Pacific (Southeast Asia), the actual destinations were examined. Figure 12 depicts the destination ICAOs for every C-17 departing PHIK or PAED. Missions that returned to

PHIK or PAED (after leaving the same location) were filtered out to exclude local training. The two most common destinations were RJTY and Andersen AFB, Guam (PGUA). Other frequently visited locations include Kadena AB, Japan (RODN), Bucholz AAF, Kwajalein Atoll (PKWA), Wake Island Airfield (PWAK), Osan AB, ROK (RKSO), Clark AB/International Airport, the Philippines (RPLC), and Misawa AB, Japan (RJSM). Every one of these primary Pacific destinations are either very near RJTY (e.g. RKSO, RJSM, RODN), or southwest of the RJTY-PHIK line (e.g. PGUA, PWAK, PKWA, RPLC).



Sum of Current Fly Time for each ACT_TAKEOFF_DATETIME Year. Color shows details about ARR_ICAOcurrent. The marks are labeled by ARR_ICAOcurrent. The data is filtered on MSN_CLASS, which keeps 17 of 17 members.

Figure 12. Actual Destinations

In order to accurately reflect where the C-17s have been positioned for missions, the departure locations were also reviewed. Figure 13 and Figure 14 depict the departure locations. Figure 13 depicts departure bases for all C-17s operating in the Pacific, while Figure 14 depicts only PACAF C-17's departure bases. As would be expected, PHIK and PAED are the most commonly used positioning bases. C-17s are based at those two locations, and those bases possess C-17 servicing and maintenance capability. Outside of the two C-17 main operating bases, RJTY, RODN and PGUA were the most common departure destinations.

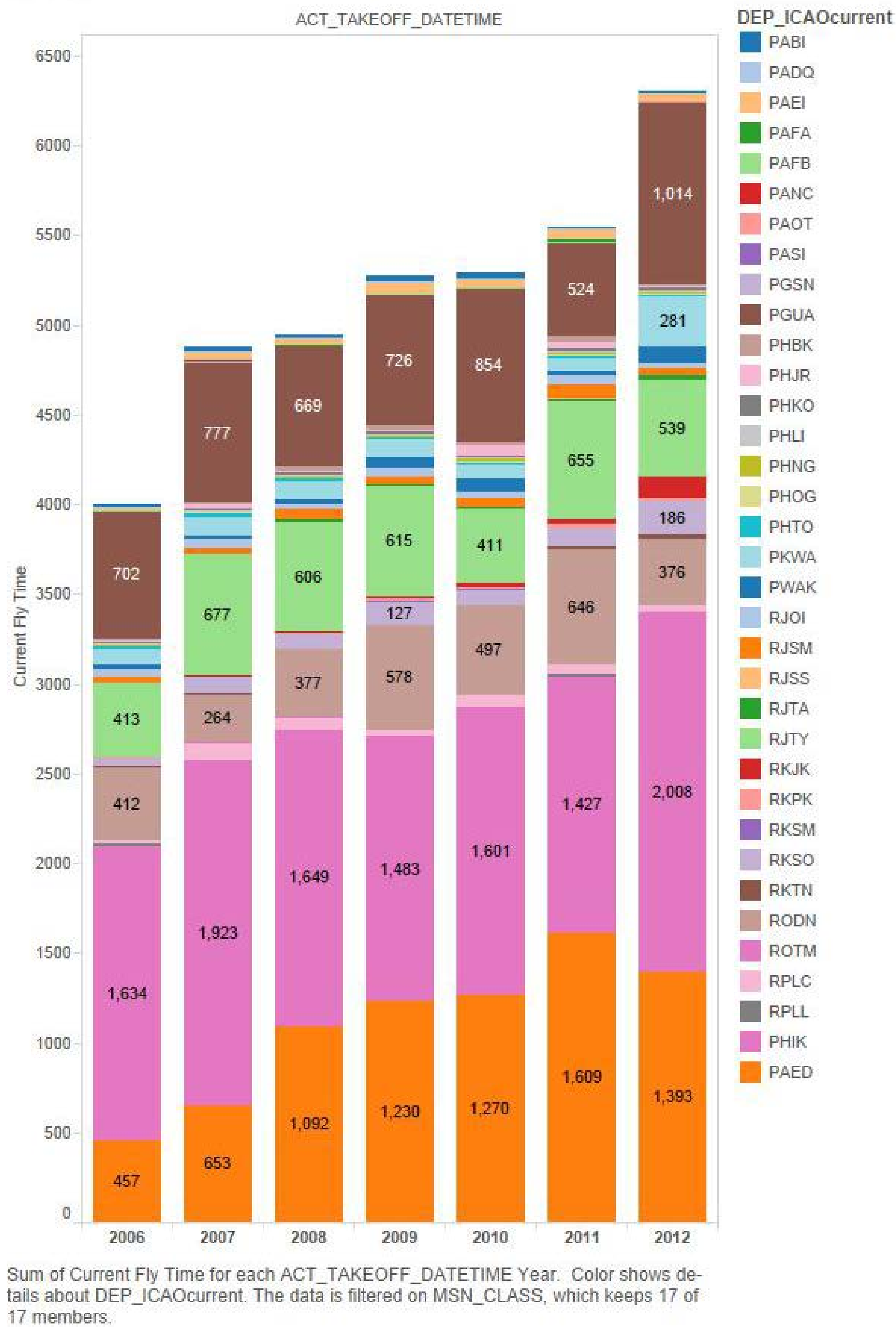


Figure 13. Departure Bases

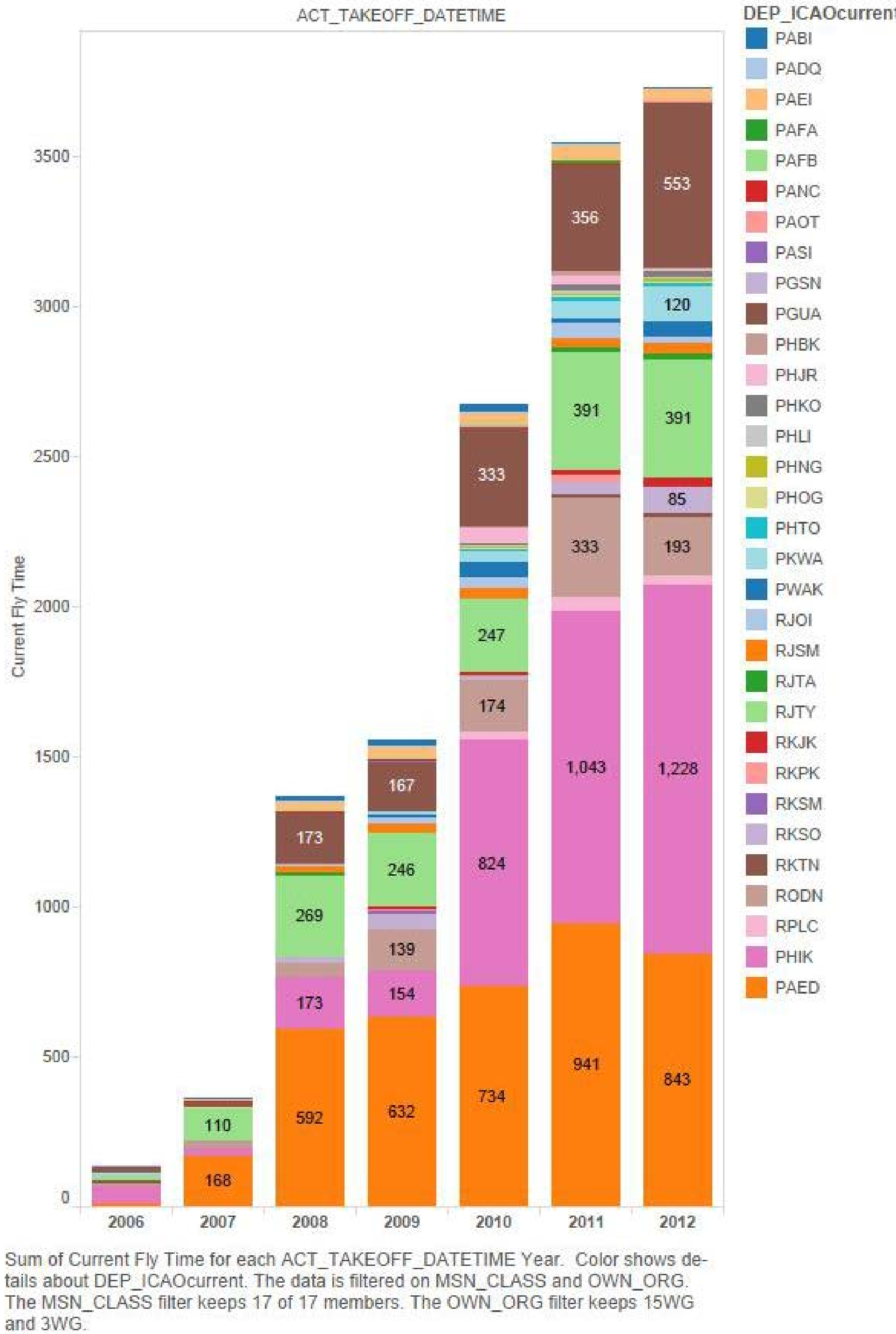


Figure 14. Departure Bases (3WG/15WG)

V. Conclusions and Recommendations

Significance of Research

The goal of this research was to determine if the airlift network design is optimized for the primary users in the Pacific theater. Simply put, are the aircraft operating from the correct locations in order to get the right stuff to the right place at the right time? The research focused on the current use of C-17s in the Pacific. The research separated the C-17 sortie data by *Mission Class*, in order to determine the weight of effort of C-17 sorties in the Pacific. The sortie data was also separated by *Owning Organization*, specifically highlighting 3rd Wing (JBER/PAED) and 15th Wing (JBPHH/PHIK) aircraft. Those two wings possess the C-17s that are assigned to PACAF and permanently based in the Pacific theater.

Conclusions of Research

Many conclusions can be drawn from the data. The primary conclusion is that based upon TWCF flight time expenditure, Yokota AB, Japan (RJTY) appears to be the optimal operating location for C-17s in the Pacific. If all C-17s operating in the Pacific in the years 2006-2012 had operated from RJTY exclusively, but had still flown their missions otherwise identically, they would have flown 16,860 less hours in TWCF missions. Based upon the FY14 hourly rate for aircraft on TWCF missions of $14,523 per C-17 flight hour (USTRANSCOM, 2014), a reduction in flight time of 16,860 hours over a six-year period would represent a savings to the DOD of almost $245 million in FY14 dollars. In particular, Channel, Contingency, and SAAM mission sets would all see flight time reductions when compared to the missions as they were actually flown.

The changes would allow DOD to realize actual savings in TWCF dollars or service additional missions with C-17s.

In addition, if the flight differences are filtered to both wartime Mission Classes as well as only 3rd Wing (PAED) and 15th Wing (PHIK) aircraft, savings would have been realized had all PACAF C-17s been assigned to a single location. If they were all based at RJTY, there would have been a flight savings of 5,666 hours over the six-year period examined. If based at PAED, there would have been a flight time savings of 2,430 hours. If all of the aircraft were based at PHIK, an additional 1,699 flight hours would have been expended. Finally, if the aircraft were based at KSUU, an additional 5,721 flight hours would have been expended.

Reviewed from an annual perspective, 2012 represents a current steady-state of C-17 operations in the Pacific. Had all of the PACAF C-17s been based at RJTY, the command would have saved 556 hours in 2012. Similarly, had AMC used RJTY as the primary C-17 operating hub instead of PHIK or PAED, they would have saved 2,589 flight hours in 2012. Overall, C-17 users would have been charged for 3,145 less hours.

The flight hour savings might lead the reader to believe that RJTY would be the top choice for C-17 basing, and PAED would be the second choice. However, as previously noted, there has been a gradual trend since 2008 of the mission focal point moving southwest within the Pacific theater. The shift in the focal point indicates a possibility of reduced savings at PAED in the future, with the outcome being that PAED and PHIK reside on relatively equal footing when compared to one another.

Recommendations for Action

The data indicates that C-17 operations should be concentrated at Yokota AB, Japan (RJTY), possibly even basing both squadrons of PACAF C-17s there. Given the current political climate, lack of appetite for another round of Base Realignment and Closure (BRAC), and the politics involved in moving aircraft, it is unlikely that the C-17s based at PHIK and PAED would be re-assigned. This study did not delve into the Japanese politics surrounding Yokota AB - or Kadena AB for that matter - so it is impossible to know whether the Japanese government would accept such a large influx of additional equipment and personnel. In addition, this study did not review the added logistical requirements of supporting two squadrons of C-17s at Yokota (e.g. hangars, aerial port, maintenance).

Aircraft could also be based closer to the focal area of the Pacific, Southeast Asia. Focusing more C-17 operations at Andersen AFB, Guam (PGUA), or Kadena AB, Japan (RODN) would be more efficient, from the standpoint of flight hours expended. As with Yokota AB, the data showed Kadena AB and Andersen AFB were locations commonly visited by C-17s. In a 2011 study on the Pacific's en route system in which the Pacific channel from Japan to Singapore and on to Diego Garcia, "both Kadena AB and Andersen AFB scored high in all models run and may be ideal for the movement of personnel, and possibly [cargo], with little to no impact to the mission support to Diego Garcia and ultimately the channel customer" (Axtell, 2011). Based upon 27 different inputs of airfield capability (e.g. MOG, road system, fuel storage, communications), Kadena AB and Andersen AFB ranked #1 and #3, respectively, of all of the airfields currently in AMC's Pacific en route structure (Axtell, 2011).

There are other possible interim solutions. In lieu of re-assigning aircraft, the USAF could consider deployments to RJTY on a rotational basis. The aircraft and crews could be rotated simultaneously or on a different schedule. Multiple C-17s could be deployed on a staggered schedule. The 515th Air Mobility Operations Wing (AMOW) is examining the feasibility of providing the required maintenance and support to deploy C-17s to Yokota AB on a rotational basis.

Recommendations for Future Research

Not discussed in this study are the operations plans classified at or above the SECRET level that impact the Pacific theater. Those plans could be reviewed in order to determine if re-assigning C-17s or deploying C-17s to RJTY would be of some benefit to those operations plans. Also, no threat analysis has been conducted to determine if Yokota AB, Japan represents a safe basing environment for C-17s. A threat analysis would need to be required for the full spectrum of operations in order to examine threats to high-value aircraft basing; threats ranging from sabotage to ballistic missiles. “By 2020, airlift forces operating at all western Pacific US bases in a major regional conflict will be subject to robust and persistent attack. By that time, China’s current force of 1,500-1,700 short range ballistic and cruise missiles may have doubled in numbers and gained precision accuracy” (Owen, 2014). Clearly, a row of parked C-17s on a ramp would represent a high-value target for any adversary.

The data presented in this study does not address the likely benefits that would result from consolidating all PACAF C-17s at a single location. If the C-17s were consolidated at RJTY or PAED and the same missions accomplished, the data indicates there would have been flight time savings. Consolidation at PHIK results in very little change to flight hours expended. However, other savings would occur. Regardless of the chosen location, there would likely be some benefits from a mission-capability standpoint. The *USTRANSCOM and USPACOM C-17 Memorandum of Agreement (2006)*, states that USPACOM will:

> 3.1.2 Provide four mission capable aircraft per unit per day, unless the number of possessed aircraft (as defined in maintenance directives) falls below eight aircraft, for an eight aircraft unit. For less than eight possessed aircraft, TWCF committed aircraft will be determined by taking 85% of possessed and subtracting two aircraft, which will be used for wing allocated Operations and Maintenance (O&M) missions.

Each wing has eight Primary Mission Aircraft Inventory (PMAI) aircraft, and one Backup Aircraft Inventory (BAI) aircraft. Quite frequently, two aircraft may not be in possessed status, meaning they are in a maintenance depot, home station maintenance, or otherwise indisposed, resulting in less than eight possessed aircraft. For example, if a wing has seven possessed aircraft, follows the C-17 MOA and takes 85% of its possessed aircraft number, and subtracts the two O&M trainer aircraft, the wing is left with 3.95 taskable aircraft. The procedure is to then round down to the next whole number to determine taskable aircraft; 3.0 in this example. If all 16 PMAI and 2 BAI C-17s were co-located, and the same situation occurred - 14 aircraft out of 18 are possessed command-wide - then 85% of 14 is 11.9. Subtract four O&M trainers and a consolidated wing would be left with 7.9 taskable aircraft. Rounding down to the nearest whole aircraft leaves 7.0 taskable aircraft; 1.0 more than the situation would present if the C-17s were split between two bases, as they currently are.

A study similar to this one could also be performed using mission data from C-130s operating in the Pacific. The PACAF C-130s based at RJTY are not used to the maximum extent possible because of their shorter range and smaller payloads, when compared to the C-17s. If the C-17s were to be re-assigned or deployed to RJTY, the C-130s might be of benefit elsewhere in the Pacific theater. For example, they could be used in JAATT and Guardlift missions in Hawaii and Alaska.

Summary

The next period for the US Air Force will be a time of drawdown, one of shrinking budgets after protracted wars in Iraq, Afghanistan, and elsewhere. New, creative solutions will be required to accomplish ever-evolving airlift mission set. The C-17 is expected to be the nation’s core airlifter for many years to come. The conclusions drawn from the data of this research study may prove useful in optimizing the use of C-17s in the Pacific.

Glossary

A2/AD	Anti-Access / Area Denial
AB	Air Base
ACARS	Aircraft Communications Addressing and Reporting System
ACFP	Advanced Computer Flight Plan
AFB	Air Force Base
AFDD	Air Force Doctrine Document
AFP	Armed Forces of the Philippines
AFRI	Air Force Research Institute
ALCT	Airlift Control Team
AMC	Air Mobility Command
AMD	Air Mobility Division
AMOW	Air Mobility Operations Wing
AOC	Air Operations Center
APOD	Aerial Port of Debarkation
APOE	Aerial Port of Embarkation
ASEAN	Association of SouthEast Asian Nations
BAI	Backup Aircraft Inventory
CCMD	Combatant Command
CDR	Commander
COCOM	Combatant Command authority
COMAFFOR	Commander of Air Force Forces
CONPLAN	Contingency Plan
CONUS	Continental United States
CY	Calendar Year
DOD	Department of Defense
EDCA	Enhanced Defense Cooperation Agreement
FCF	Functional Check Flight
FOB	Forward Operating Base
FT	Fuel Tracker
FY	Fiscal Year
GATES	Global Air Transportation Execution System
GDSS	Global Decision Support System
GEF	Guidance for Employment of the Force
GFM	Global Force Management
GFMIG	Global Force Management Implementation Guidance
GRP	Graduate Research Paper
HA/DR	Humanitarian Assistance / Disaster Relief
JAATT	Joint Airborne Air Transportability Training
JBER	Joint Base Elmendorf-Richardson
JBPHH	Joint Base Pearl Harbor-Hickam
JCS	Joint Chiefs of Staff
JFC	Joint Force Commander
JP	Joint Publication

JS	Joint Staff
KSUU	Travis Air Force Base, California
KTO	Korean Theater of Operations
LZ	Landing Zone
MAC	Military Airlift Command
MAF	Mobility Air Forces
MATS	Military Air Transport Service
MCAS	Marine Corps Air Station
MCS	Mobility Capabilities Study
MFOQA	Military Flight Operations Quality Assurance
MHE	Material Handling Equipment
MOA	Memorandum of Agreement
MOB	Main Operating Base
MODSS	Mobility Air Forces Operations Decision Support System
MOG	Maximum On Ground
MRS	Mobility Requirements Study
O&M	Operations and Maintenance
OPCON	Operational Control
OPLAN	Operations Plan
ORI	Operational Readiness Inspection
OT&E	Organize, Train, and Equip
PACAF	Pacific Air Forces
PAED	Joint Base Elmendorf-Richardson (Elmendorf Field), Alaska
PERISC	Pacific En Route Infrastructure Steering Committee
PGUA	Andersen Air Force Base, Guam
PHIK	Joint Base Pearl Harbor-Hickam (Hickam Field), Hawaii
PKWA	Kwajalein Atoll Airfield
PMAI	Primary Mission Aircraft Inventory
PWAK	Wake Island Airfield
RIMPAC	Rim of the Pacific Exercise
RJSM	Misawa Air Base, Japan
RJTY	Yokota Air Base, Japan
RKSO	Osan Air Base, Republic of Korea
RODN	Kadena Air Base, Okinawa, Japan
RPLC	Clark Air Base / International Airport, Philippines
SAAM	Special Assignment Airlift Mission (also SAM)
SECDEF	Secretary of Defense
TACC	Tanker Airlift Control Center
TACON	Tactical Control
TPFDD	Time-Phased Force Deployment Data
TWCF	Transportation Working Capital Fund
US	United States
USAF	United States Air Force
USPACOM	United States Pacific Command
USTRANSCOM	United States Transportation Command

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14. ABSTRACT Substantial savings may be realized by optimizing C-17 flight operations in the Pacific. Aligning the C-17 operating locations to the mission demand may reduce flight hour expenditure by decreasing the positioning and de-positioning requirements. This research paper evaluated C-17 missions in the Pacific during calendar years 2006 through 2012. JB Pearl Harbor-Hickam, Hawaii, JB Elmendorf-Richardson, Alaska, Yokota AB, Japan, and Travis AFB, California, were used as the four test bases for purposes of comparison and optimization. Based upon Transportation Working Capital Fund (TWCF) flight time expenditure, Yokota AB appears to be the optimal operating location for C-17s in the Pacific. If all C-17s operating on TWCF missions in the Pacific in 2006-2012 had operated from Yokota AB exclusively, but had still flown their missions otherwise identically, they would have flown 16,860 less hours. Based upon the FY14 TWCF rate for C-17s, that reduction would represent a savings to the DOD of almost $245 million in FY14 dollars. In particular, Channel, Contingency, and SAAM mission sets would all see flight time reductions when compared to the missions as they were actually flown. The changes would allow DOD to realize actual savings in TWCF dollars or service additional missions with C-17s.		
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